

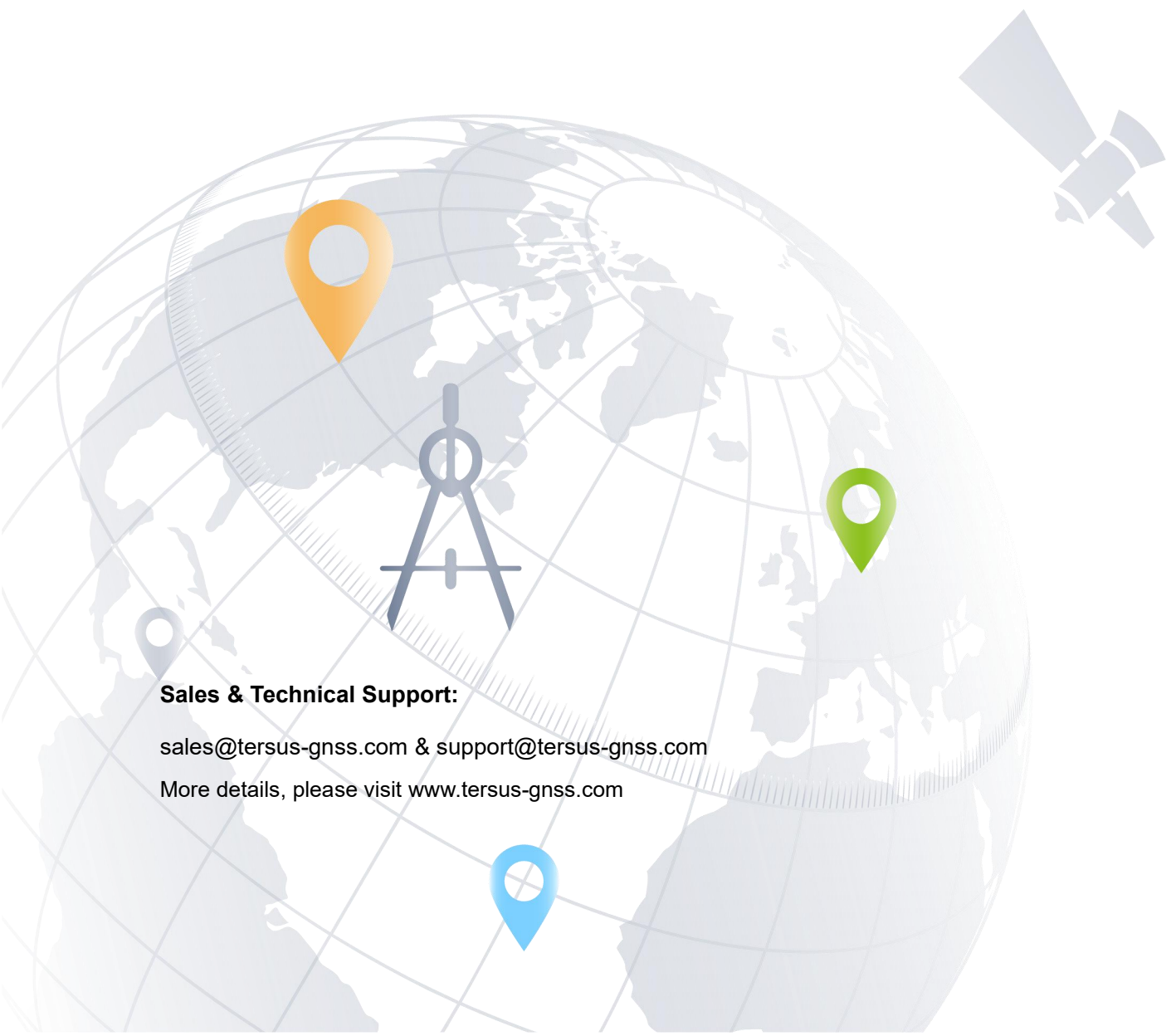
## User Manual

Version V1.3-20190529



# User Manual For Nuwa App

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## Revision History

Revision	Description	Date	Owner
1.0	Issued for Release	2018/08/08	LC
1.1	Added detailed description for device info and satellite info interfaces. Added predefined CRS for users to import Added Geoid CRS option Update section 4.7 Base Shift Added chapter for TC20 controller Added section 7.4 Issues and Solutions Other minor changes and fixes	2018/12/28	LC
1.2	Updated section 1.2 Installation; Added section 1.3 Update Nuwa; Updated cover photo; Updated section 7.2.2 File Downloading and section 7.2.3 Data Post Processing	2019/04/03	LC
1.3	Updated section 3.1 Connect	2019/05/29	LC

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## 1. Nuwa Brief Introduction

- Introduction
- Main Interface
- Installation

## 1.1 Introduction

Nuwa is a survey application software based on Android OS (Operating System), designed by and all rights reserved to Tersus Inc. Nuwa is simple, easy to use and has friendly UI (User Interface). It is designed to work with David GNSS receiver specifically, read <https://www.tersus-gnss.com/product/david-receiver> for more information about David GNSS Receiver.

Main features of Nuwa App:

- All the base/rover configuration can be completed by one click
- Supports user-defined coordinate system
- Supports several import/export file formats
- With Nuwa, a David receiver can work as a NTRIP server and upload RTK corrections in real time.
- Supports text and graphics interface, providing a variety of options; with convenient data sharing capabilities;
- Supports new release detection and online upgrades.

## 1.2 Installation

There are two methods of installing Nuwa app in an android device.

- 1) Search Nuwa in Google Play Store, click [Install], install the application and open it after the installation is completed. The screenshots are as follows.

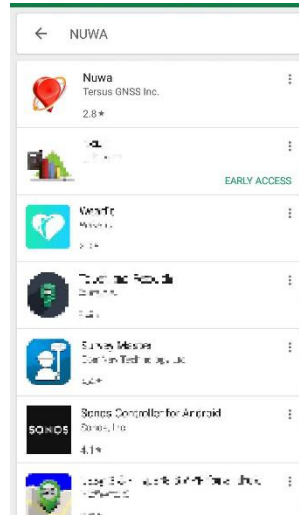


Figure 1.1 Nuwa in Google Play Store

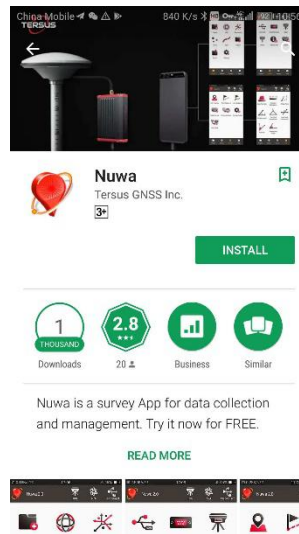


Figure 1.2 Nuwa in Google Play Store – install

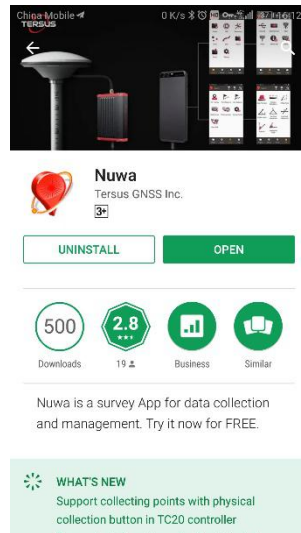


Figure 1.3 Nuwa in Google Play Store – open

- 2) Copy the .apk file to the storage of an Android device, click it to start installation. The Nuwa icon will be on the desktop after it is installed successfully.

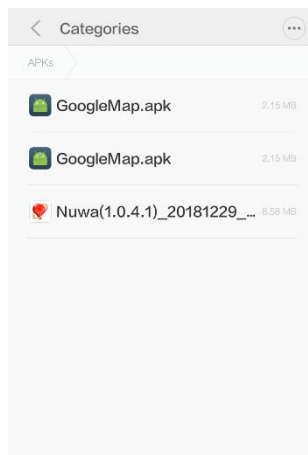


Figure 1.4 Nuwa copied in an android device

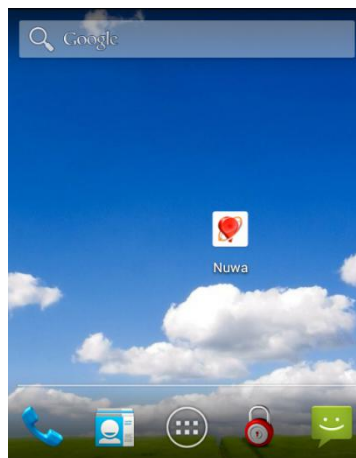


Figure 1.5 Nuwa icon on desktop



### 1.3 Update Nuwa

There are three methods of updating Nuwa app in an android device.

- 1) Update Nuwa in Google Play Store which is shown below.

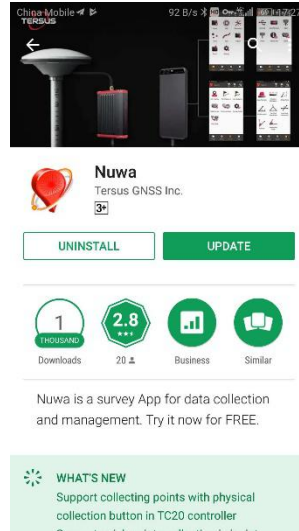


Figure 1.6 Update Nuwa in Google Play Store – 1

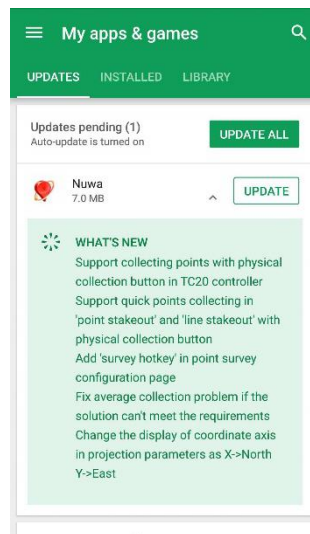


Figure 1.7 Update Nuwa in Google Play Store – 2

- 2) Update Nuwa by copying the latest .apk installation file to the storage of an android device. The process is the same with that in the above section of installation.
- 3) Update Nuwa in the 'Settings' page inside Nuwa app. In the condition that the android device is connected to internet, click [Settings] on the Nuwa main interface and it can be seen that there is red 'new' on the right of version number if current Nuwa version is detected to be ready to update.

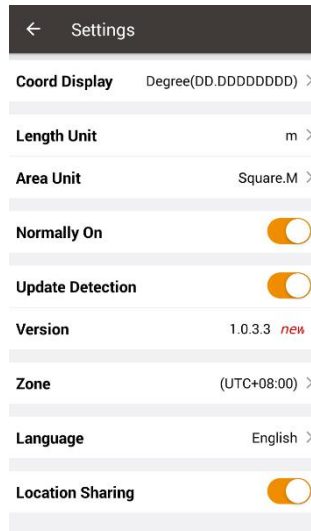


Figure 1.8 Version in Settings page

Tap the row of version, it pops out a window indicating software update. Select [Update] to update the app automatically. Select [Later] to ignore this notification.

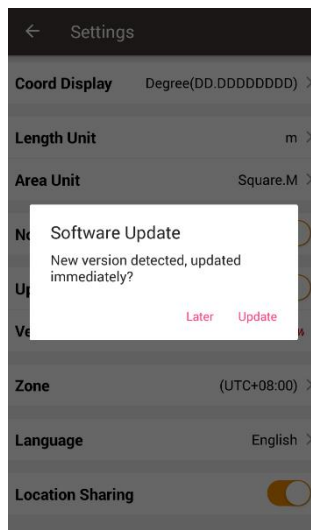


Figure 1.9 Software Update notification

## 1.4 Main Interface

Nuwa has four main functional groups: Project, Device, Survey and Tools.

While Nuwa is running, slide left or right on the screen to enter other functional groups.

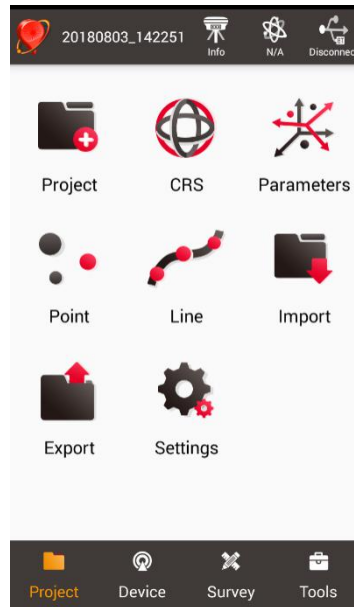






Figure 1.10 Nuwa Main Interface

### ➤ Status Bar

[ 20180803\_142251]: Project Information, the current project is displayed.

[]: Device information, click it to check details about the David connected. The screenshot is shown in Figure 1.11 below. Contact Tersus Technical Support if the registration is not effective.

[ N/A]: Satellites status, N/A indicates Not Available, satellite positioning status includes: Single, Float and Fixed. Click this icon to view satellite information which is shown in Figure 1.12 ~ 1.15 below.

[]: Connection status, can be Connected or Disconnect. Click this icon to connect device as shown in Figure 1.16 if current status is 'Disconnect'.

### ➤ Menu area

List all the menu items in the current functional group.

➤ Tabs Bar

Four functional groups: Project, Device, Survey and Tools.

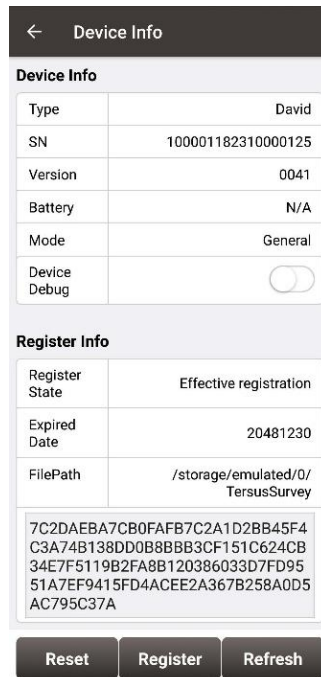


Figure 1.11 Device Info

In the figure above, when the registration is not effective, click [Register] after putting the registration file (obtained from Tersus Technical Support) into the specified FilePath, then click [Refresh] to update the registration status.

Clicking [Reset] resets David into factory settings.

When David has an unknown error, turning on Device Debug to record Tersus specific data to debug David which can help us better improve David function.

**Note: This function and static survey cannot be turned on at the same time. Please manually turn off the static survey before using Device Debug.**

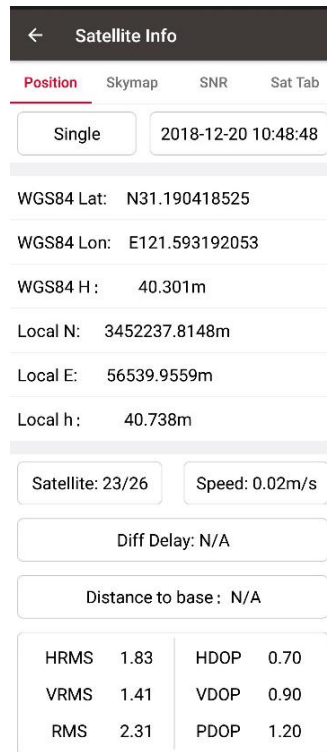


Figure 1.12 Satellite Info – Position

In the figure above, 'Single' indicates the current solution status of the receiver. The solution status includes Fixed, Float, DGPS, Single, Base Manual and Base Auto.

Clicking the box of date and time can switch time zone, clicking 'WGS84 Lat' or 'WGS84 Lon' can switch unit from options of Degree (DD.DDDDDD), DM (DD:MM.MMMM) and DMS (DD:MM:SS.SS), clicking 'WGS84 H' or 'Local N' or 'Local E' or 'Local h' can switch unit from options of km, m, inch, and feet.

'Satellite: 23/26' indicates that there are 23 satellites used and 26 satellites tracked.

'Speed: 0.02m/s' is the moving speed of the receiving antenna.

'Diff Delay: 1' indicates that the differential delay is 1 second.

'Distance to base: 1.52m' means the distance between rover and base is 1.52m.

HRMS, VRMS and RMS indicate the horizontal, vertical and total value of root mean square.

HDOP, VDOP and PDOP indicate the horizontal, vertical and position of dilution of precision.

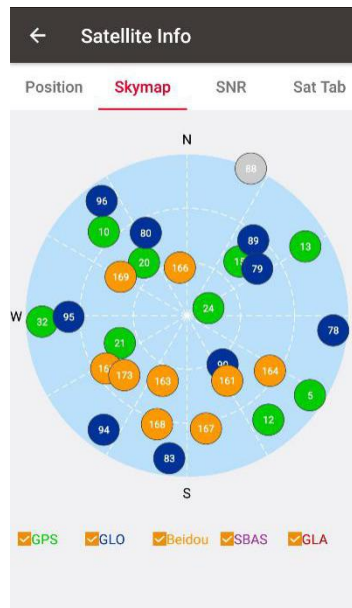


Figure 1.13 Satellite Info – Skymap

In the figure above, the sky map displays the elevation angle and azimuth of satellites of different satellite systems. A satellite at the center of the circle means its elevation angle is 90 degrees, a satellite on the circumference means its elevation angle is 0 degree. At the bottom of this interface, one or more constellations can be ticked to display.

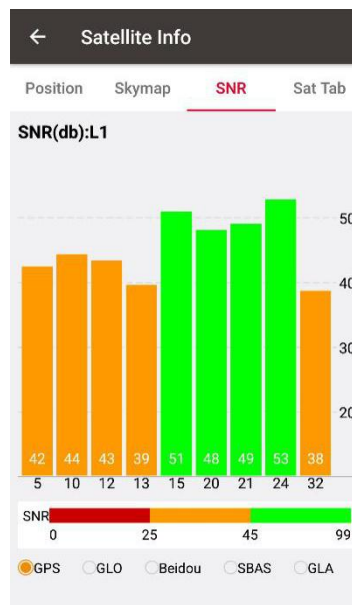


Figure 1.14 Satellite Info – SNR

In the figure above, it shows the SNR (Signal Noise Ratio) of different satellites in specified constellation. Clicking the histogram area can switch the SNR between L1 and L2. This screenshot is taking GPS L1 for example.

← Satellite Info						
Position	Skymap	SNR		Sat Tab		
Type	Prn	Azi	Ele	L1	L2	Lock
GPS	13	59	13	36	21	Used
GPS	15	44	47	49	43	Used
GPS	20	321	52	49	37	Used
GPS	21	247	49	47	38	Used
GPS	24	69	77	53	49	Used
GPS	32	267	9	38	37	Used
GLONASS	88	23	0	0	0	Un-used
GLONASS	80	333	38	46	0	Used
GLONASS	96	323	10	44	42	Used
GLONASS	90	142	55	47	47	Used

Figure 1.15 Satellite Info – Sat Tab

In the figure above, it shows the satellite information in table which including satellite type, PRN code, azimuth, elevation angle, SNR value of L1, SNR value of L2, and satellite using status.

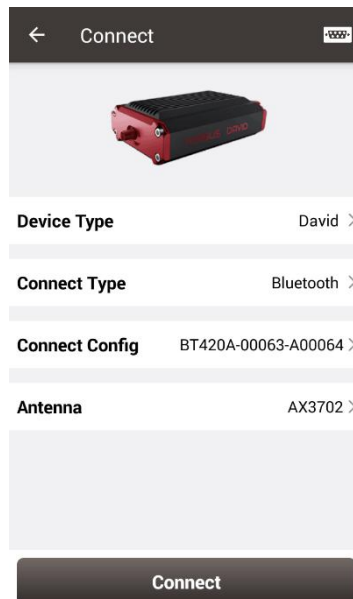


Figure 1.16 Connect Device

Click the connection status icon on the up right corner of the main interface to the step of connecting device which is shown in Figure 1.16.

## 2. Project

- Project
- CRS (CooRdinate System)
- Parameters
- Point
- Line
- Import
- Export
- Settings

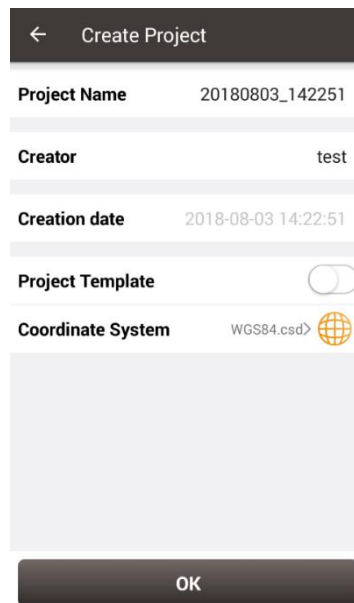


## 2.1 Project

This section introduces how to create a new project, open / delete / edit an existed project.

### 2.1.1 New

A new project is necessary to manage all the data. On the Nuwa main interface as shown in Figure 1.10, click [Project] - > [New] to go to the following interface.




Create Project	
Project Name	20180803_142251
Creator	test
Creation date	2018-08-03 14:22:51
Project Template	<input type="checkbox"/>
Coordinate System	WGS84.csd 
OK	

Figure 2.1 Create Project interface

[Project Name]: input the project name

[Creator]: input the name of the operator

[Project Template]: use an existed project settings

[Coordinate System]: configure a new coordinate system

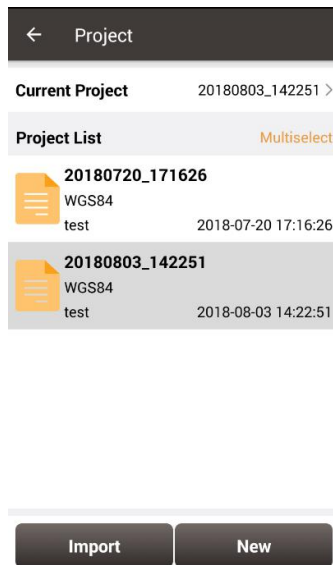


Figure 2.2 New project created

After a project is created, this project is displayed in the Current Project. Refer to section 2.1.5 for more details about project property.

### 2.1.2 Import

In the Figure 2.2, an existed project can be imported from the storage of the android device by clicking [Import] on the bottom left of the interface.

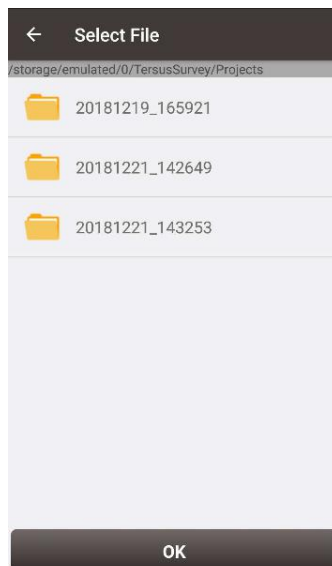


Figure 2.3 Project folders in an Android device

When importing projects from other sources, click [Import], select the folder where the project files are located which is shown in Figure 2.3, and click [OK].

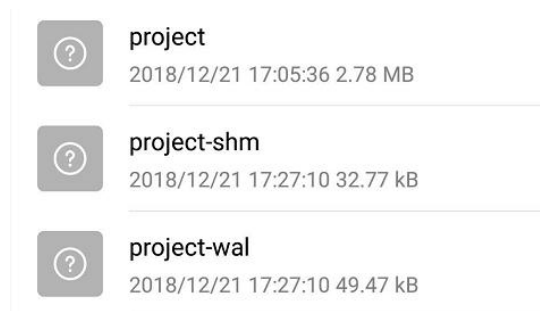


Figure 2.4 Sketch file containing the project info

**Note: The imported project file needs to have a sketch file containing the project information (Project / Project-shm / Project-wal).**

### 2.1.3 Open

If there is need to operate in an existed project, find it in the project list and click it. Nuwa prompts to open the project, click [OK].

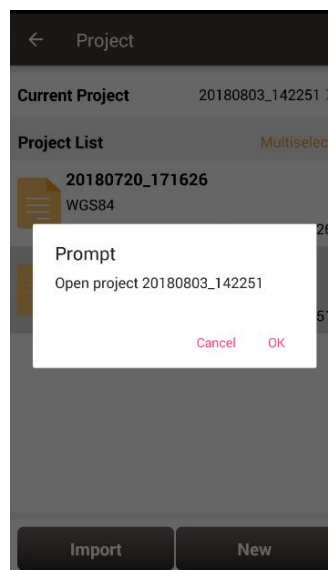


Figure 2.5 Open an existed project

### 2.1.4 Delete

Click [Multiselect] at the right side of Project List, select (single select, inverse select or select all) projects to be deleted. After the projects are selected, click [Delete] button to delete them. Nuwa prompts to confirm, click [OK] to complete the deletion.

**Note: The current Project cannot be deleted in Nuwa app.**

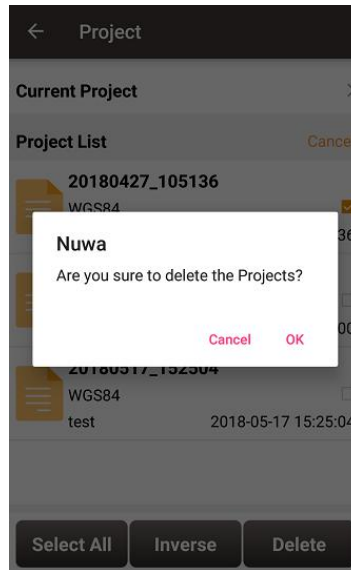


Figure 2.6 Delete Project

### 2.1.5 Edit Project Property

If a project is opened, the coordinate system can be edited, including ellipsoid, projection method and coordination transformation.

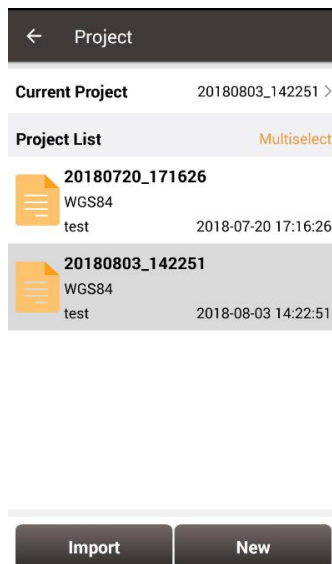


Figure 2.7 Project List

Click the [Current Project] to enter Project Property interface.

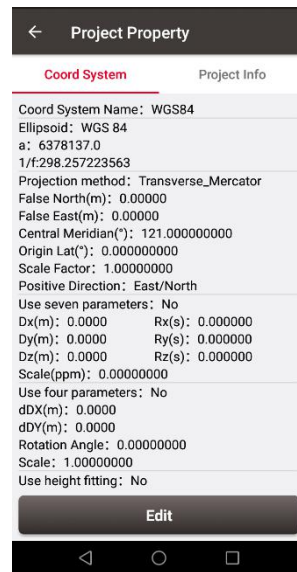


Figure 2.8 Project Property

Click [Edit] to input the ellipsoid parameters, projection type and coordination transformation, refer to section 2.2.2 for details.

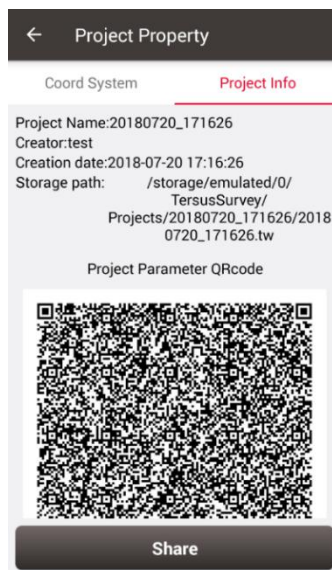


Figure 2.9 Share Project Info

Click [Share] to share the project parameters with others. The detailed usage refers to section 2.2.1.

## 2.2 CRS (CooRdinate System)

Nuwa app supports user-defined coordinate system. A user-defined coordinate system can be saved as a template. A CRS can be created, imported, edited and deleted in the

CRS management interface.

On the Nuwa main interface as shown in Figure 1.10, click [CRS] to get the coordinate system list which is shown below.

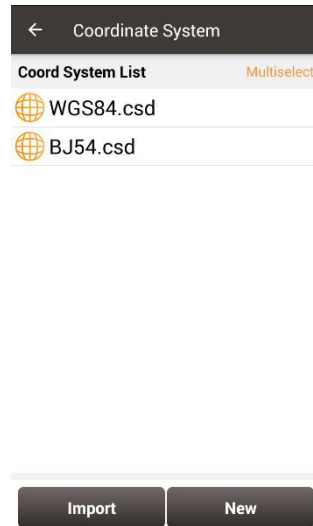


Figure 2.10 Coordinate System List

### 2.2.1 New CRS

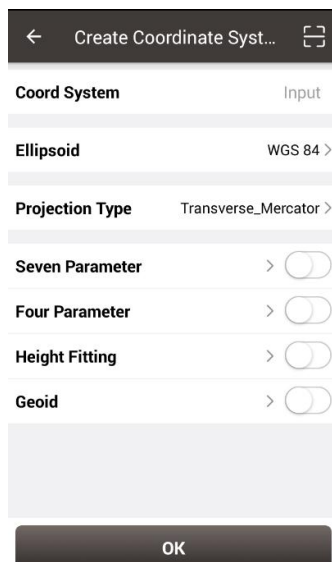


Figure 2.11 Create a new CRS

Click [New] to create a new CRS, input the coordinate system name, select the right ellipsoid, projection type and CRS transformation type, refer to the following screenshots:

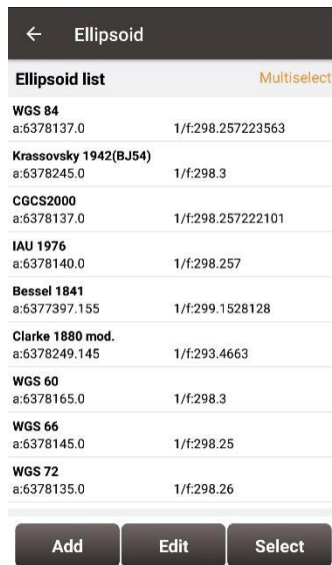


Figure 2.12 Ellipsoid list

[Ellipsoid]: Select the correct ellipsoid parameters, including ellipsoid name, semi-major axis, inverse flattening, etc. There is no need to configure semi-major axis, inverse flattening by further steps.

**Note: The default ellipsoid is WGS84**

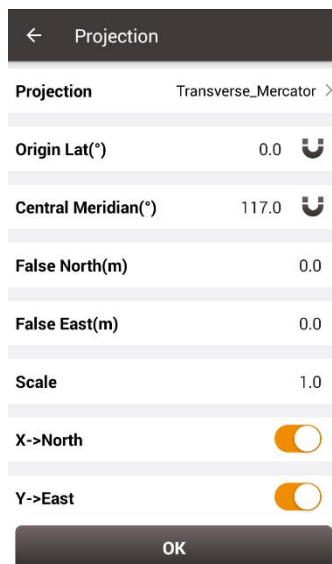


Figure 2.13 Projection interface

[Projection Type]: Including Transverse Mercator projection, UTM projection, Lambert conformal conic projection 1SP, Lambert conformal conic projection 2SP, and etc which is listed as below.

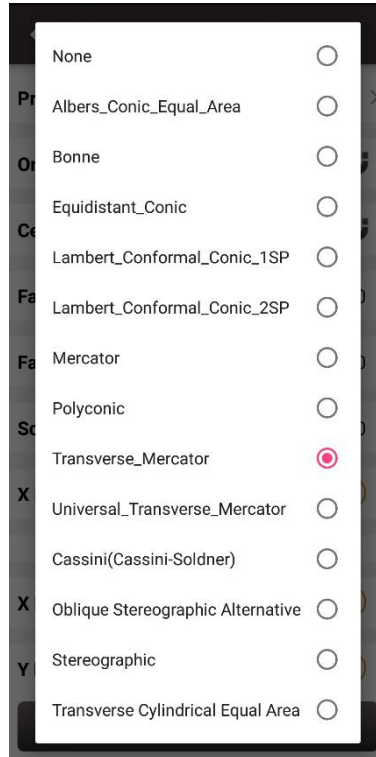


Figure 2.14 Projection list

Origin latitude, central meridian and other parameters can also be configured in Projection interface which is shown above. Fill in these information according to the actual needs. Turn on [X -> North] to indicate that the positive part of X axis is north, negative part is south. Turn on [Y -> East] to indicate that the positive part of Y axis is east, negative part is west.

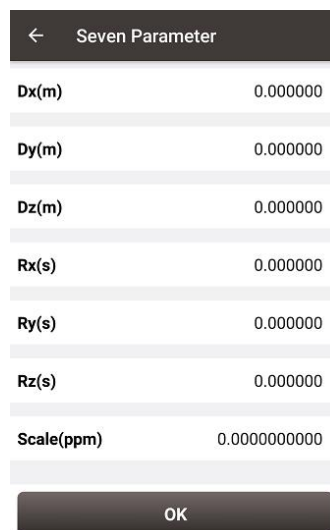
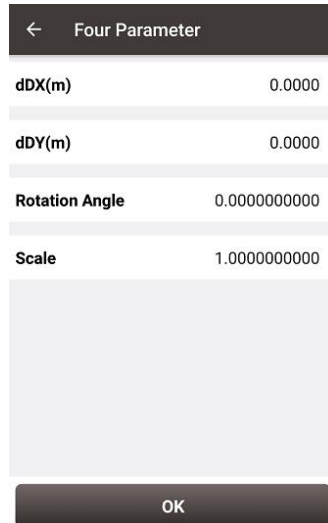


Figure 2.15 Seven Parameter

[Seven Parameter]: Datum transformation is necessary when the source ellipsoid is



different from the target ellipsoid. Axis shift, rotation and scale would be introduced in the datum transformation. Bursa-Wolf seven-parameter model is used by Nuwa for datum transformation from local coordinate to WGS84 system. At least three known points are necessary for accurate transformation. Only X/Y/Z shifts are required only if three parameter transformation is needed, other parameters can adopt the default values.

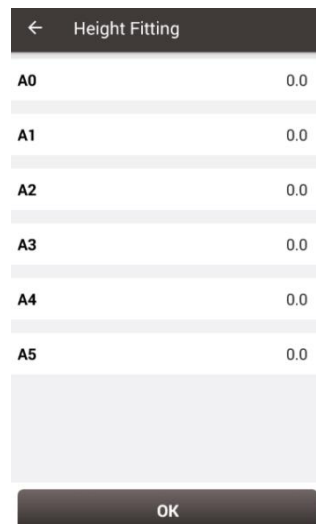


Four Parameter	
dDX(m)	0.0000
dDY(m)	0.0000
Rotation Angle	0.0000000000
Scale	1.0000000000

OK

Figure 2.16 Four Parameter

[Four Parameter]: For the transformation between two planes. X/Y axis shift, rotation and scale are necessary to be input.



Height Fitting	
A0	0.0
A1	0.0
A2	0.0
A3	0.0
A4	0.0
A5	0.0

OK

Figure 2.17 Height Fitting

[Height Fitting]: currently three algorithms are supported: fixed difference correction, plane fitting and surface fitting.

[Geoid]: Currently Geoid supports EGM96 and EGM08, details refer to section 0.

Click the corresponding items to complete the configuration.


Click the scan icon  in the top right corner of Figure 2.11, open the camera to scan other surveyor's coordinate system parameters to copy information for creating a new CRS.



Figure 2.18 Scan QR code to get CRS info

The following shows detailed steps:

- 1) The copied surveyor opens in turn: [Project] -> [Current Project] -> [Project Information], then displays the complete QR code;
- 2) The current surveyor opens the camera to scan the QR code displayed as shown in Figure 2.18 above and can copy its coordinate system parameters. The QR code screenshot in photo album can also be scanned to obtain the CRS parameters.

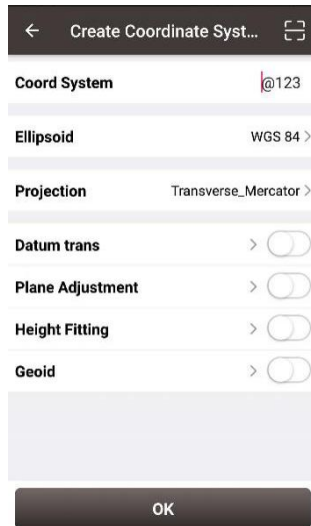


Figure 2.19 CRS info obtained by scanning QR code

3) The coordinate system parameters are obtained as shown in the figure above.

### 2.2.2 Import CRS

Click [Import] on the bottom left of CRS interface which is shown in Figure 2.10, it shows predefined coordinate systems for users to choose.

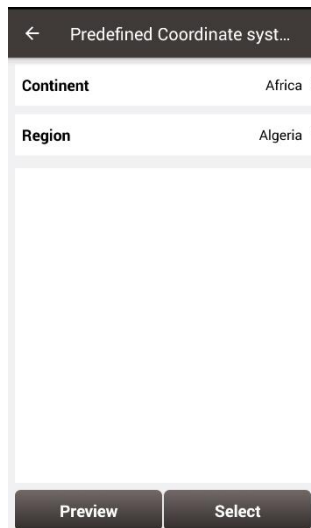


Figure 2.20 Predefined CRS

In the figure above, the predefined coordinate systems are classified by continent and region.

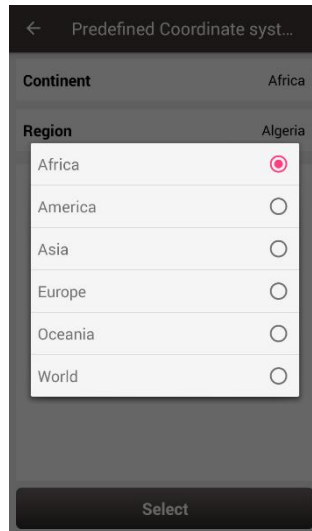


Figure 2.21 Continent options

The continent option includes Africa, America, Asia, Europe, Oceania and World as shown in the figure above. Select a continent, a country or a region, then select a CRS and click [Preview].

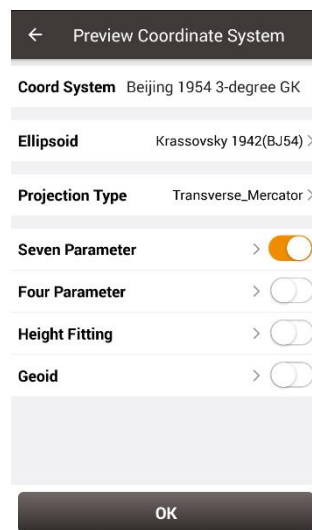


Figure 2.22 Preview of predefined CRS

Figure 2.22 is a preview of 'Beijing 1954 3-degree GK CM 075E' coordinate system. Click [OK] and [Select] this CRS, the CRS file is imported to Coordinate System List as shown in Figure 2.23.

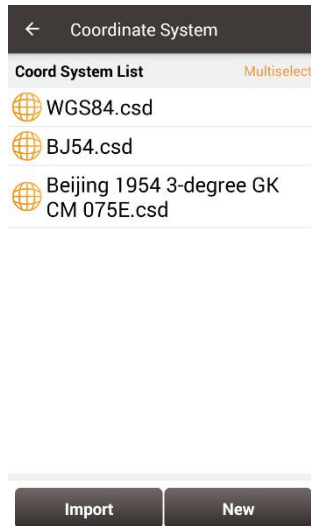


Figure 2.23 Example of CRS import

Please contact Tersus Technical Support if users cannot find CRS in their country or region.

### 2.2.3 Edit CRS

Click an existed CRS to enter the Edit Coordinate System interface, refer to the following screenshot:

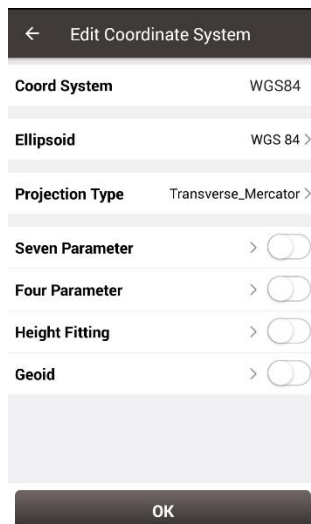


Figure 2.24 Edit Coordinate System

## 2.2.4 Geoid

Geoid supports EGM96 and EGM08, it optimizes data loading, reduces waiting time for different devices, simplifies algorithm calculation process and saves system resources. Click the button on the right side of Geoid in Figure 2.24 to turn on this function which is shown in Figure 2.25 below.

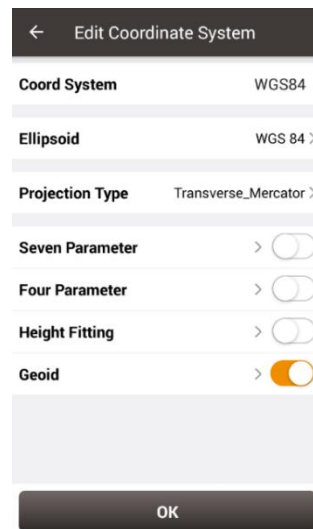


Figure 2.25 Turn on Geoid

Click [Geoid] to get the Geoid list as shown in Figure 2.26.

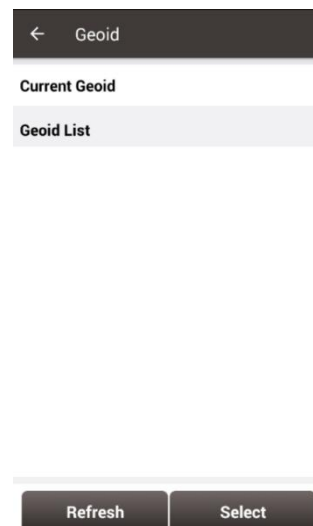


Figure 2.26 Geoid list without Geoid files

Currently there is no available Geoid files displayed on this screenshot. Contact Tersus Technical Support [support@tersus-gnss.com](mailto:support@tersus-gnss.com) to inquire about the Geoid files with .ggf format.

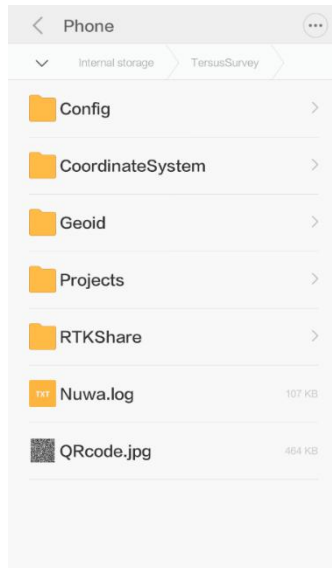


Figure 2.27 Explore Geoid folder in the phone

Copy and paste the Geoid files under the Geoid folder of TersusSurvey as shown above, back to the Geoid list interface and click [Refresh] to view the available Geoid list as shown below.



Figure 2.28 Select a Geoid source

Select one suitable Geoid model and click [Select] to complete the Geoid configuration.

**Note: When Height Fitting and Geoid model are turned on at the same time, the two models become effective simultaneously.**

## 2.2.5 Delete CRS

The current CRS cannot be deleted. Click [Multiselect] to select the CRS to be deleted and click [Delete] to finish the deletion.

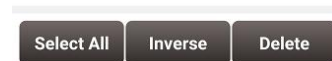
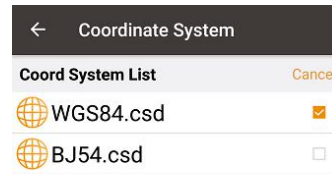


Figure 2.29 Delete CRS

## 2.3 Parameters

Seven Parameter and Three Parameter methods are introduced in this section.

**Seven Parameter:** this method can cover long distance range, generally more than 50 km. At least three known points are required in local datum and in WGS84 system before calculating.

**Three Parameter:** at least one known point is required. This method can cover short distance range; the accuracy is determined by working area and decreased with the distance.

The following is an example of Seven Parameter. Click [Project] -> [Parameters] to enter the following interface.



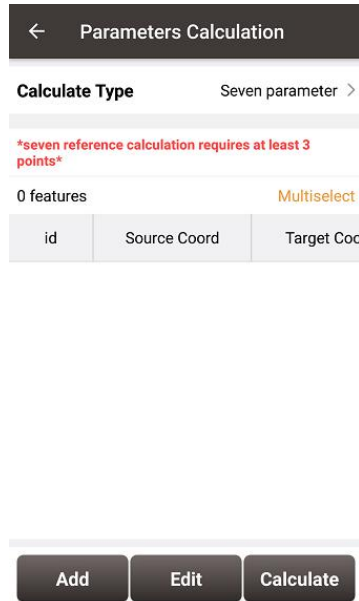


Figure 2.30 Parameters Calculation

Select seven parameter for Calculate Type, click [Add] on the bottom left to input the known points.

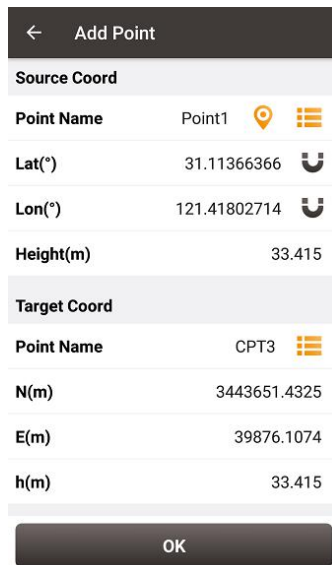


Figure 2.31 Add Point for calculation

For the Source Coordinate, input Latitude, Longitude and Height by manual input, collected from a David receiver or selected from the control point list. For the Target Coordinate, input the local values from manual input or selected from the control point list.

- Manual input

Input the point position according to the format required. The latitude/longitude format can be changed by clicking the U icon on the right.

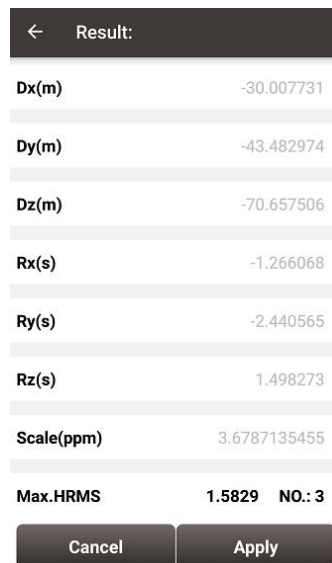
- Control Point

Click [ 📄 ] to load control points. Control points can be added by clicking [Add] in the Control Point interface.

- Smooth Acquisition

Click [ 📍 ] to start smooth acquisition through David receiver.

After points are added, click [Calculate] on the bottom right to do the parameter transformation. The result is shown as below screenshot:



← Result:	
Dx(m)	-30.007731
Dy(m)	-43.482974
Dz(m)	-70.657506
Rx(s)	-1.266068
Ry(s)	-2.440565
Rz(s)	1.498273
Scale(ppm)	3.6787135455
Max.HRMS	1.5829 NO.: 3

Cancel Apply

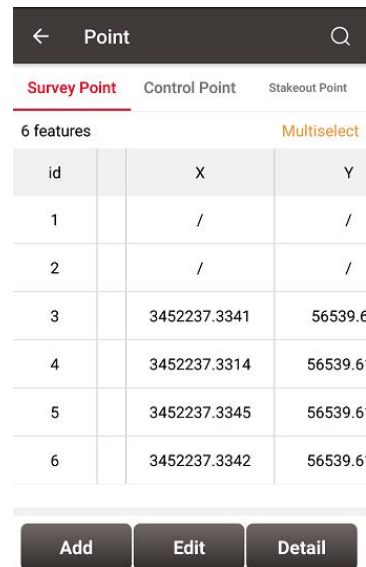
Figure 2.32 Parameters Calculation Result interface

**Note: Before this calculation, please make sure that the project parameters (ellipsoid, projection, etc.) are used correctly.**

## 2.4 Point

Point library includes survey point library, control point library and stakeout point library.

Points can be added into a library. Editing, searching and checking detail information can be done under this Point interface.



← Point			
Survey Point Control Point Stakeout Point			
6 features		Multiselect	
id		X	Y
1		/	/
2		/	/
3		3452237.3341	56539.6
4		3452237.3314	56539.6
5		3452237.3345	56539.6
6		3452237.3342	56539.6

Add Edit Detail

Figure 2.33 Point Interface

A point can be imported into the control point library or the stakeout point library. In the point library interface, slide in the left or right direction to check the point information, such as coordinates, collection time, and etc.

### 2.4.1 Add Point

Under the Control Point interface, click [Add] to enter the Add Control Point interface.

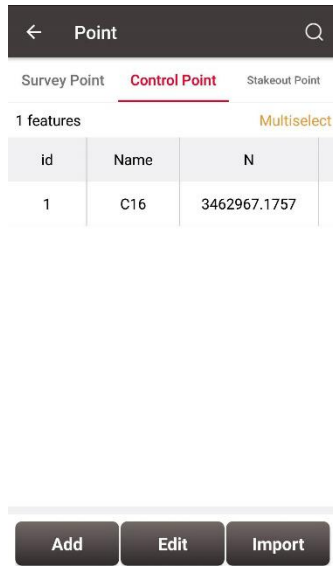


Figure 2.34 Control Point interface

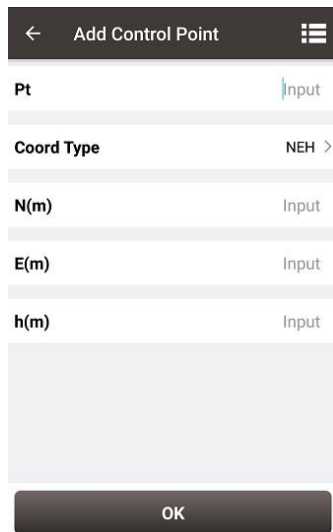

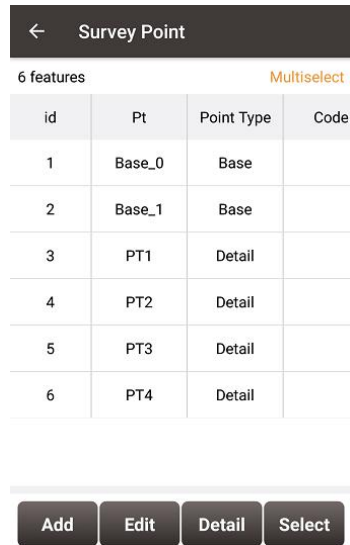


Figure 2.35 Add Control Point

Choose the coordinate type, input the point name and the coordinate values, or click the upper right  icon to import the survey point directly.



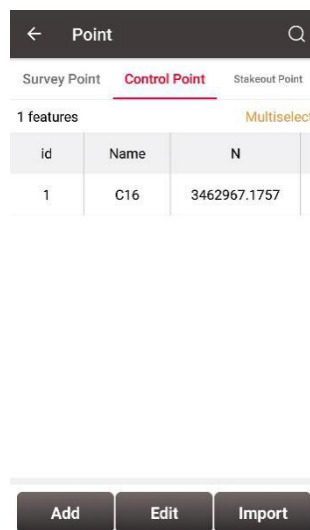
← Survey Point			
6 features			Multiselect
id	Pt	Point Type	Code
1	Base_0	Base	
2	Base_1	Base	
3	PT1	Detail	
4	PT2	Detail	
5	PT3	Detail	
6	PT4	Detail	

Add Edit Detail Select

Figure 2.36 Import Survey Point

Under the Stakeout Point interface, adding stakeout point is similar with that of adding control point.


## 2.4.2 Search Point



← Point		
Survey Point <b>Control Point</b> Stakeout Point		
1 features		Multiselect
id	Name	N
1	C16	3462967.1757

Add Edit Import

Figure 2.37 Control Point interface

Click the up-right  icon to enter Point Query interface which is shown in the figure above. Target Points can be survey points, control points or stakeout points.

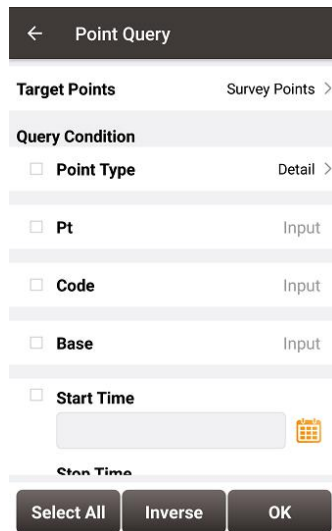


Figure 2.38 Point Query interface

Query condition details are as follows:

[Point Type]: Detail, continuous, input point, calculate or base.

[Pt]: Point name to be queried.

[Code]: Code number.

[Base]: The name of the base.

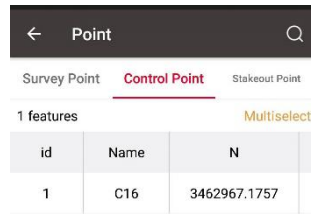
[Start/Stop Time]: Start and stop time of the points

Click [OK] to search all the points meeting the query conditions.

### 2.4.3 Edit Point

Choose the points to be edited, and click [Edit] to enter the Edit interface.

**Note:** *There is an exception that in the Survey Point tab, only the code info can be edited apart from the manual input points.*



id	Name	N
1	C16	3462967.1757

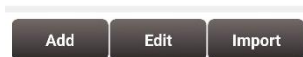


Figure 2.39 Control Point interface

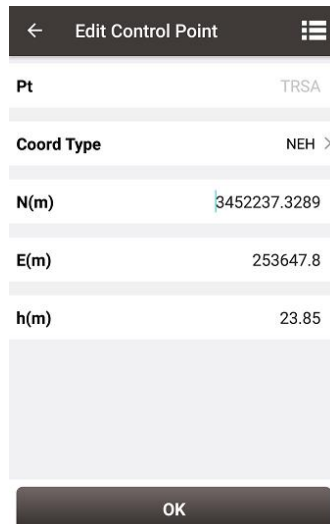


Figure 2.40 Edit Control Point interface

Editing Stakeout Point is similar with the steps of editing control point.

## 2.4.4 Import Point

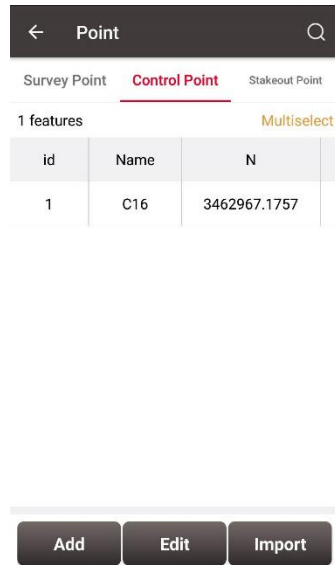


Figure 2.41 Control Point interface

Under the Control Point interface, click [Import] at the bottom right corner.

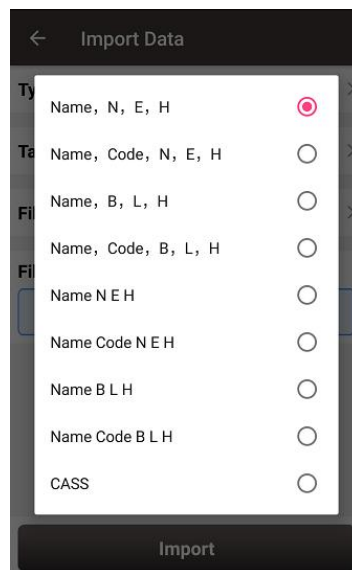


Figure 2.42 Format list

Select a customized format in the pop-up list which is shown in Figure 2.42.



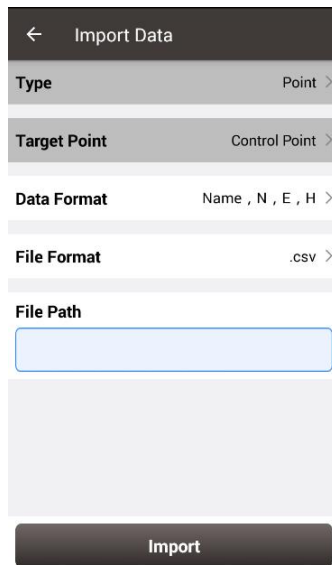


Figure 2.43 Import Data info

Select file format and file path to import points.

Under the Stakeout Point interface, click [Import] at the bottom right corner, select a source in the pop-up list. Choosing [From File] leads to the similar steps of importing Control Point. Choosing [From Survey Point] leads to the Figure 2.45 below. One or more points can be selected and imported as Stakeout Points.

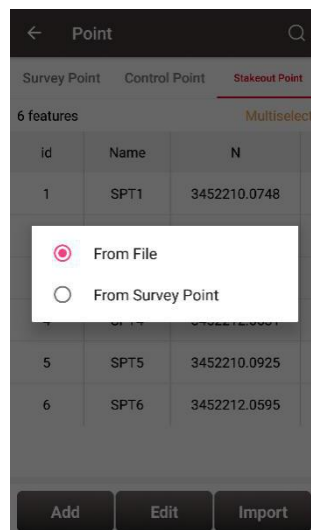
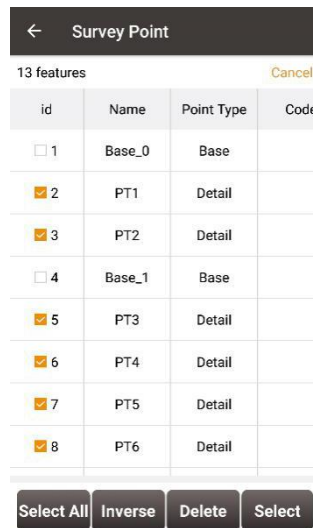


Figure 2.44 Import source for Stakeout Point

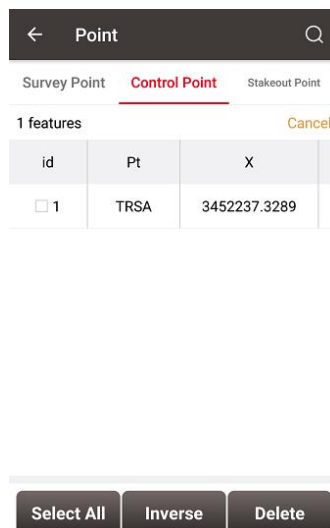


id	Name	Point Type	Code
<input type="checkbox"/> 1	Base_0	Base	
<input checked="" type="checkbox"/> 2	PT1	Detail	
<input checked="" type="checkbox"/> 3	PT2	Detail	
<input type="checkbox"/> 4	Base_1	Base	
<input checked="" type="checkbox"/> 5	PT3	Detail	
<input checked="" type="checkbox"/> 6	PT4	Detail	
<input checked="" type="checkbox"/> 7	PT5	Detail	
<input checked="" type="checkbox"/> 8	PT6	Detail	

Figure 2.45 Import from Survey Point

## 2.4.5 Delete Point

Click [Multiselect] in the point interface to enter the following interface. Select the points to be deleted and click [Delete] to complete the deletion.



id	Pt	X
<input type="checkbox"/> 1	TRSA	3452237.3289

Figure 2.46 Delete Point interface

## 2.5 Line

New lines can be added, existed lines can be searched, edited and deleted.

### 2.5.1 Add Line

Click [Project] - > [Line] to enter the line interface.

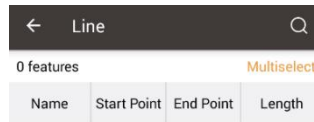


Figure 2.47 Line interface

Click [Add] to enter the following two interface for Add Line

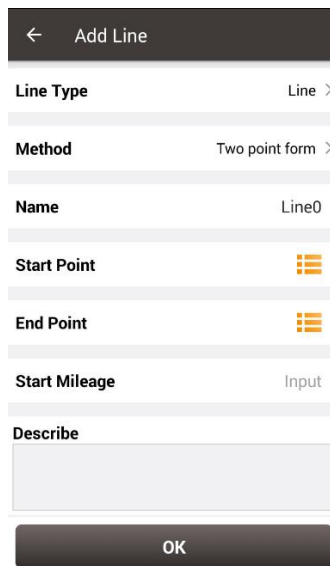


Figure 2.48 Add Line method 1

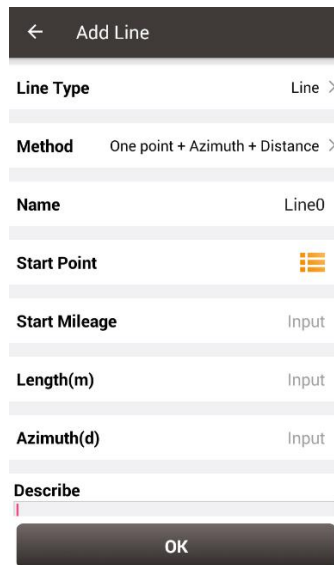



Figure 2.49 Add Line method 2

Two methods are used to add a line: Two Points and One point + Azimuth +Distance.

- Two Points:


Input the name of the line, then click  to import the start point and end point.

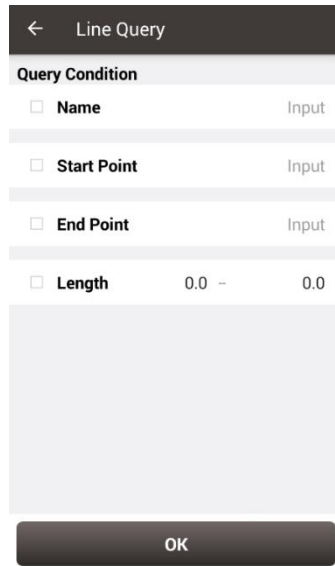
- One point + Azimuth + Distance

Input the name of the line, then click  to import the start point from a point library.

Input the other information for the line.

## 2.5.2 Search Line

Click the  icon at the up-right corner, the line query interface is shown as below. Input the search items and tick the item, click [OK] to search the line.



Line Query

Query Condition

Name Input

Start Point Input

End Point Input

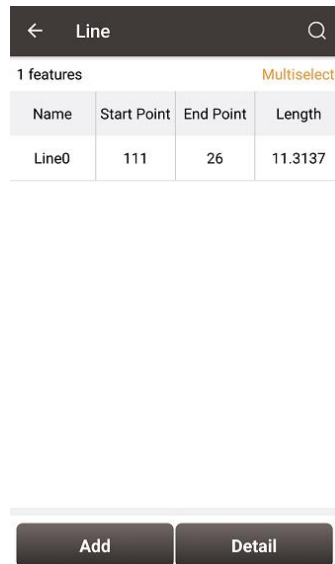
Length 0.0 - 0.0

OK

Figure 2.50 Line Query interface

### 2.5.3 Edit Line

In the Line interface, select the line to be edited. Then click [Detail] to enter the edit page, more details about edit refer to section 2.5.1 Add Line.



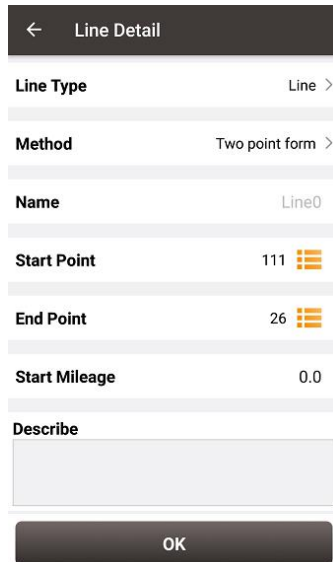
Line

1 features Multiselect

Name	Start Point	End Point	Length
Line0	111	26	11.3137

Add Detail

Figure 2.51 Line interface



Line Detail

Line Type Line >

Method Two point form >

Name Line0

Start Point 111 ☰

End Point 26 ☰

Start Mileage 0.0

Describe

OK

Figure 2.52 Line Detail interface

## 2.5.4 Delete Line

In the Line interface, click [Multiselect] to enter the following interface. Tick the line to be deleted, then click [Delete] to complete deletion.



Line

3 features Multiselect

Name	Start Point	End Point	Length
Line0	Pt1	Hai	423.1014
Line1	PT2	Mi	1954.8745
Line2	Hai	Mi	1455.2184

Add Detail

Figure 2.53 Line interface



Figure 2.54 Tick the line to be deleted

## 2.6 Import

There are two types of import: Coordinate Import and Other Import. Coordinate import is to import files with .csv and .dat format. Other Import is to import files with .dxf and .shp format. Currently .dxf and .shp files are not supported.

### 2.6.1 Coordinate Import

Under the Coordinate Import interface, select Type, Target Point library to be added, Data Format, File Format and the file path where the file is located, click [Import] to complete the import.

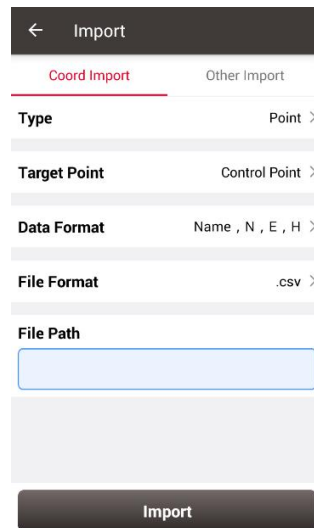


Figure 2.55 Import interface

The Figure 2.55 shows the parameters that should be selected or filled for coordinate import. It includes Type, Target Point, Date Format, File Format, and File Path.

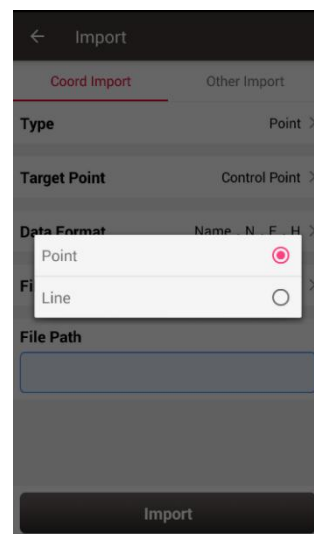


Figure 2.56 Import Type

For point import, select [Point] for Type as shown in Figure 2.56 above.



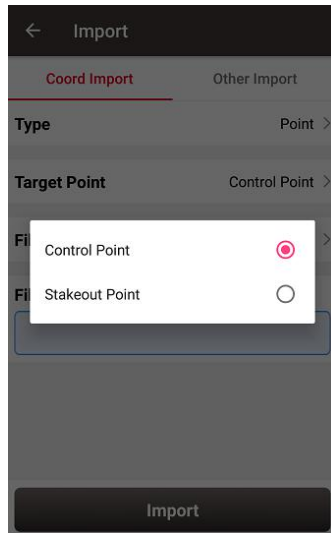


Figure 2.57 Target Point Library

The target point library has two options: control point and stakeout point as shown in Figure 2.57 above.

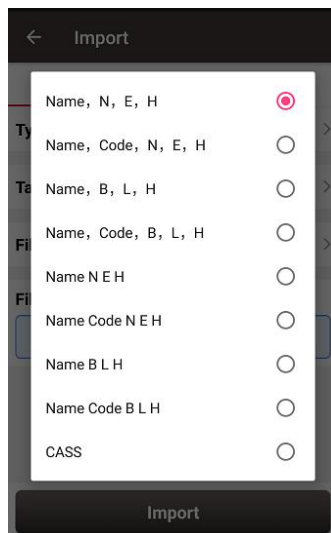


Figure 2.58 Data Format options

The data format options for data import are listed in Figure 2.58 above.

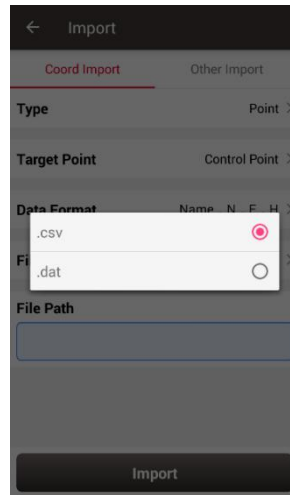


Figure 2.59 File Format options

There are two options for file format of imported points: .csv and .dat files.

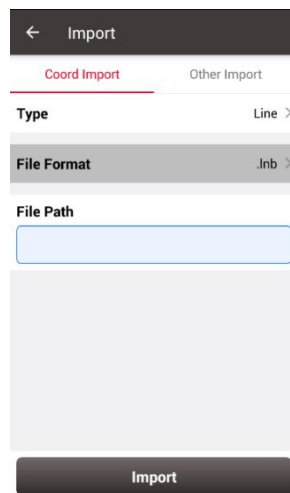


Figure 2.60 Import Line interface

For line import, select [Line] for Type in Figure 2.56 and it goes to the import line interface as shown in Figure 2.60 above. The file format for line is .lnb file.

The line file is a text file with the .lnb extension in nature. The detailed content in the text file is shown as below. The information from left to right is: starting point name, starting point N, starting point E, starting point h, 0, ending point name, ending point N, ending point E, ending point h, 0, 0.

```
5K+250-1,3453407.198,496492.9505,0,0,5K+250-2,3453312.565,496460.4625,0,0,0
5K+300-1,3453388.743,496542.6277,0,0,5K+300-2,3453300.967,496507.4977,0,0,0
5K+350-1,3453368.497,496589.9064,0,0,5K+350-2,3453277.249,496550.8326,0,0,0
```

Figure 2.61 Example content in the .lnb file

## 2.6.2 Other Import

Under the Other Import interface, select the file type and the file path, click [Import] to import the file. Currently this function is not support and is to be developed.

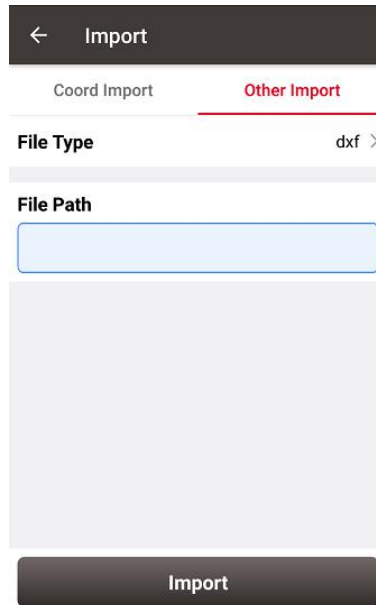


Figure 2.62 Other Import interface

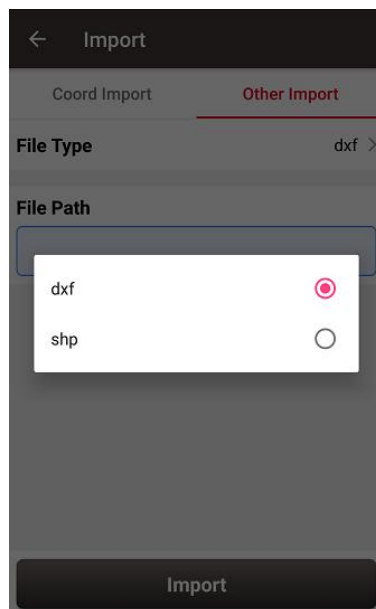


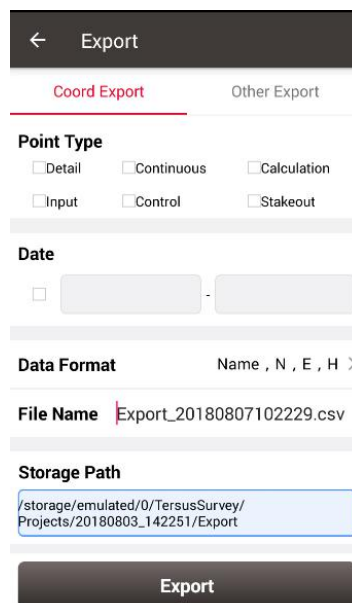
Figure 2.63 File Type for other import

## 2.7 Export

Correspondingly there are two types of export: Coordinate Export and Other Export. Coordinate Export is to export .csv files, Other Export is to export files with .kml, .shp and .dxf format.

### 2.7.1 Coordinate Export

Under the Coordinate Export interface, select Point Type, Date range and Data Format, ensure the File Name and Storage Path is correct.



The screenshot shows the 'Export' interface with the following fields and options:

- Export** (Title)
- Coord Export** (Selected) / Other Export
- Point Type**
  - Detail
  - Continuous
  - Calculation
  - Input
  - Control
  - Stakeout
- Date**
  - [Date Range]
- Data Format** Name , N , E , H >
- File Name** Export\_20180807102229.csv
- Storage Path** /storage/emulated/0/TersusSurvey/Projects/20180803\_142251/Export
- Export** (Button)

Figure 2.64 Export Interface

Thereafter click [Export] to complete the export.

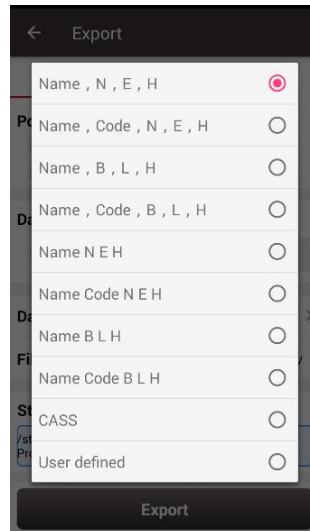


Figure 2.65 Data Format options

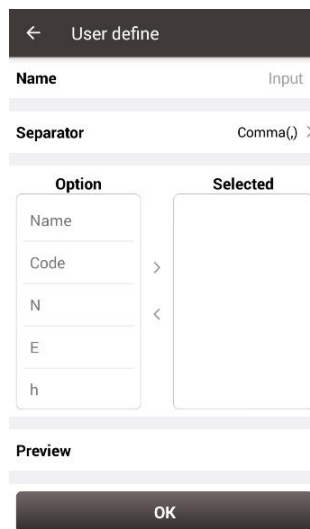


Figure 2.66 User defined data

For Data Format, there is a list of options provided to select, and a user-defined format can be created.

### 2.7.2 Other Export

Under the Other Export interface, file format can be KML, SHP or DXF. Type in the export file name and click [Export] to complete the file export. Please be noted that KML file is the BLH coordinate under the WGS84 coordinate system, SHP / DXF file is the NEH format coordinate under the local coordinate system.

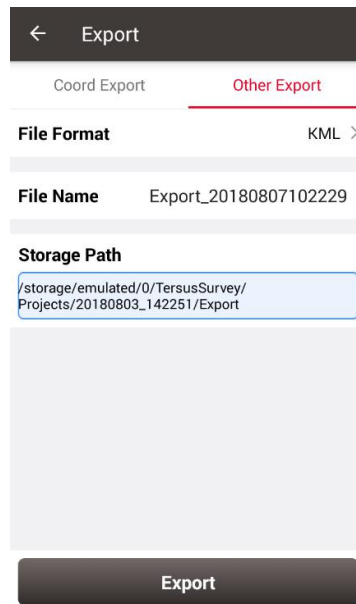


Figure 2.67 Other Export interface

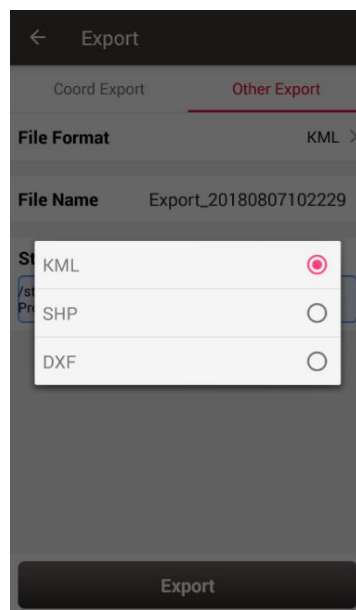


Figure 2.68 File Format for other export

## 2.8 Settings

Settings interface is shown as below, the function descriptions is as follows.

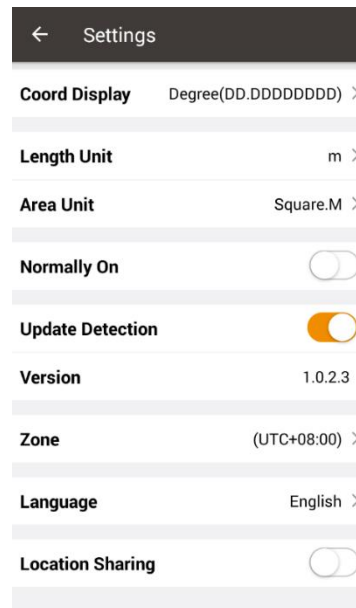


Figure 2.69 Settings interface

[Coord Display]: can be selected from degree (DD.DDDDDDDDD), DM (DD:MM.MMMM) or DMS (DD:MM:SS.SS).

[Length Unit]: can be selected from Km, meter, Inch or Feet.

[Area Unit]: can be selected from Mu, Square Km, Square Meter, Hectare and Acre.

[Normally On]: the screen would be always on if it is enabled.

[Update Detection]: Auto update detection is on if it is enabled.

[Version]: the current version of the Nuwa app.

[Zone]: select the time zone according to the current position.

[Language]: support Auto, Chinese, English, French, Spanish, German, Portuguese, Italian, Russian, Japanese, Korean, Malay, Arabic, Thai, and Turkish.

[Location Sharing]: the location would be shared with other apps if it is enabled.


### 3. Device

- Connect
- Data Terminal
- Base
- Rover
- Device Info
- Demo



### 3.1 Connect

There are two ways to enter the Connect interface: Click [Device] -> [Connect] or click

 [Disconnect] on the up right corner in the status bar. Screenshots and descriptions are as follows.

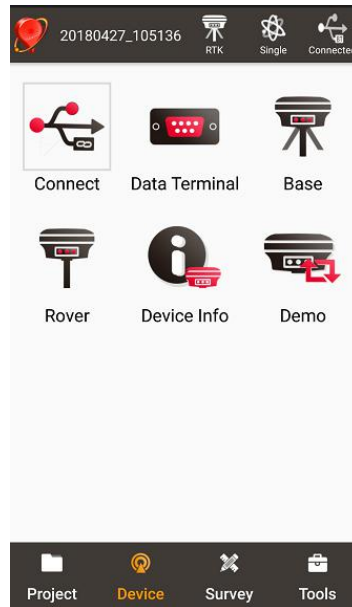


Figure 3.1 Device functional group

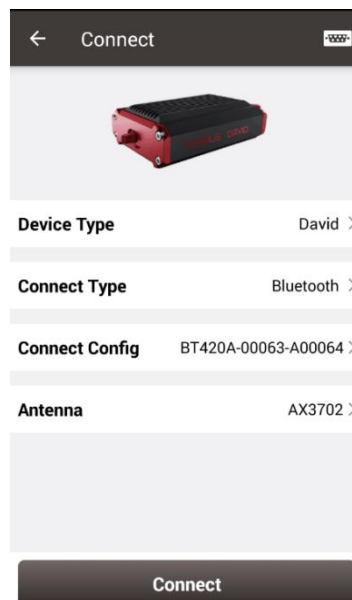


Figure 3.2 Connect interface – David

**[Device Type]**: can be selected from David, Oscar or NMEA<sup>1</sup> devices.

[**Connect Type**]: can be selected from USB or Bluetooth.

[**Connect Config**]: shows the device name to be connected

[**Antenna**]: can be selected from the antenna list. An antenna with user-defined parameters can be used.

**Note:**

- 1) **NMEA devices should be able to output one of following data: GGA / GSA / GSV / GST / RMC/ RANGEB.**

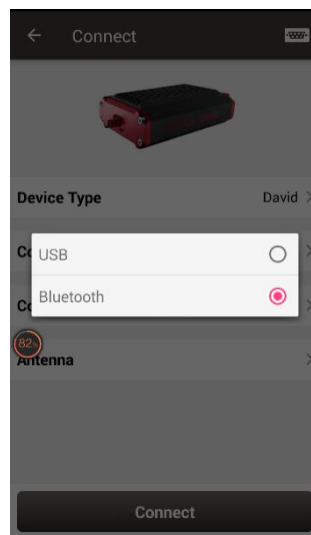


Figure 3.3 Two connection types for David

- USB connection: David can be connected to an android device using a 'USB Type A Female to USB (Micro+Type C) OTG cable' in the package. The detailed connection refers to *User Manual for David GNSS Receiver*.
- Bluetooth connection: David can be connected to an android device via wireless method – Bluetooth using 'COMM1-Bluetooth module' in the package.
  - 1) Add Bluetooth to the list: select Bluetooth for the [Connect Type], click [Connect Config] and [Search], choose the Bluetooth module to be paired.
  - 2) Remove paired Bluetooth: long press the paired Bluetooth name in the Bluetooth list to remove this paired Bluetooth device in the list.

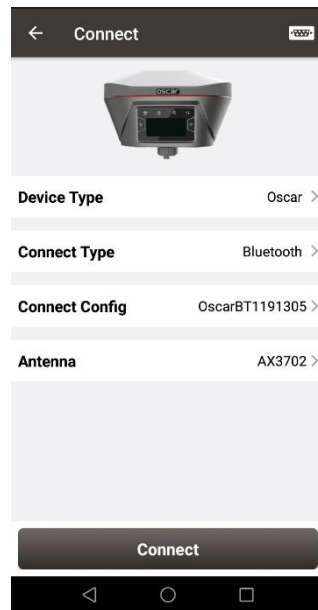


Figure 3.4 Connect interface – Oscar

Currently the connection type for Oscar is Bluetooth only, the other connection types are under development. Stay tuned for the updates.

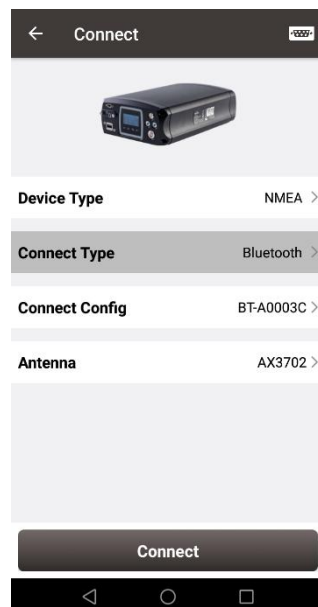


Figure 3.5 Connect interface – NMEA

Currently this connect interface is showing MatrixRTK as an example. In fact, other NMEA devices which support NMEA 0183 can also be connected. For NMEA devices, only Bluetooth is used for connect type.

Click [Antenna] to enter the Antenna Manage interface which is shown as below.

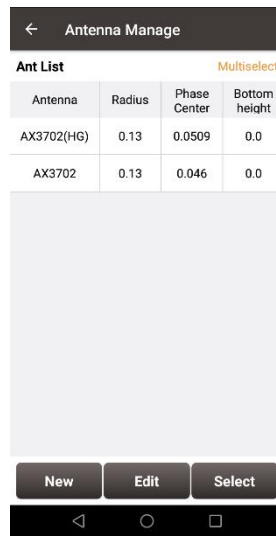


Figure 3.6 Antenna Mange interface

Click [New] in the left bottom corner to add new antenna parameters which is shown as below.

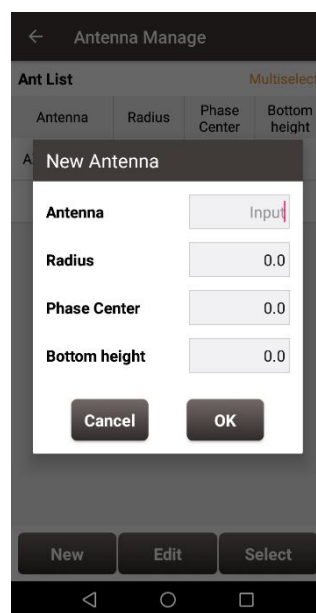


Figure 3.7 Parameters for New Antenna

[Antenna]: input the antenna name for the new antenna.

[Radius]: input the radius of the new antenna when measuring the slant height. Input 0.13 when using the height measure accessory provided by Tersus.

[Phase Center]: input the height from the antenna phase center to the antenna bottom.

[Bottom height]: input the height from the antenna circumference to the antenna bottom.

**Note: the unit for the above three parameters is meter (m).**

The following figure explains the above three parameters taking AX3702 antenna for example.

### Antenna Phase Center

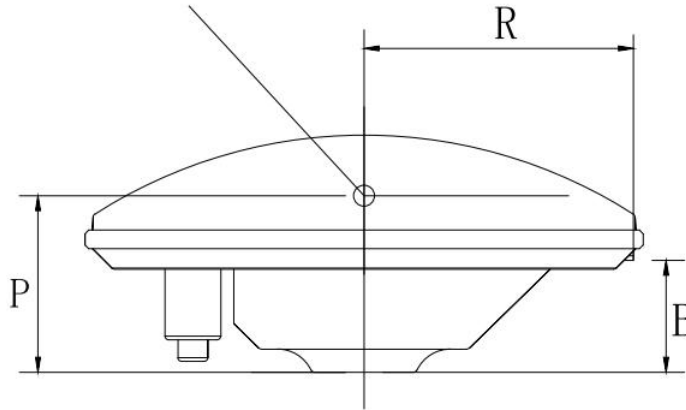


Figure 3.8 Antenna parameters explanation

## 3.2 Data Terminal

In the data terminal interface, the output loggings can be monitored as shown below. It is outputting ASCII data when David is connected with AX3702 GNSS antenna and it is working normally.

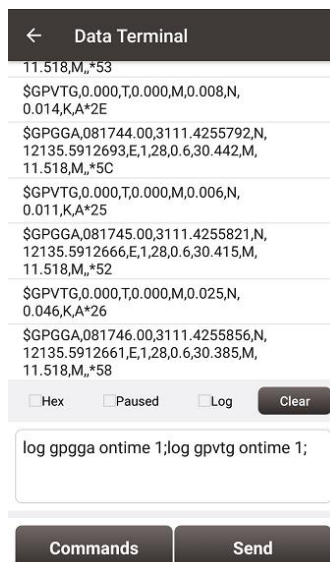


Figure 3.9 Data Terminal interface

Check the box on the left of [Hex] to enable the above window output hex data which is shown below.

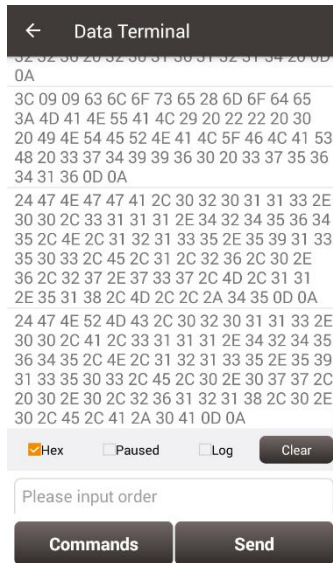


Figure 3.10 Data Terminal outputs hex data

Check the box on the left of [Paused] to pause the output logging.

Check the box on the left of [Log] to start recording log data. The log data is saved in a .txt file. Create file name in the pop-up window as shown below.

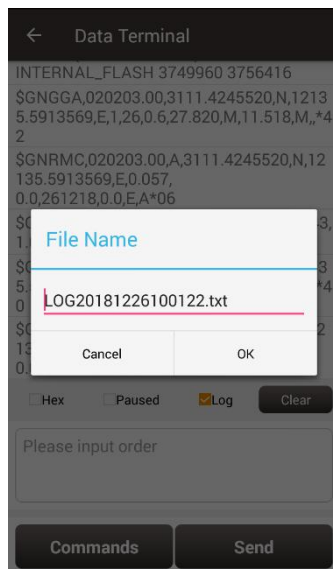


Figure 3.11 Create File Name

Click [OK] to confirm the file name, it automatically starts recording log data and stores the data in the default folder `/storage/emulated/0/TersusSurvey/GpsLogger/xxxxxx.txt`.

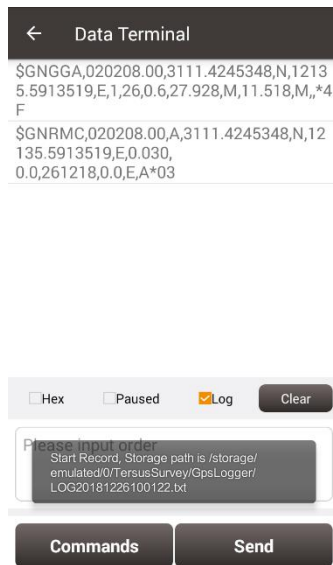


Figure 3.12 Start recording log data

Uncheck the box on the left of [Log] is to stop recording log data

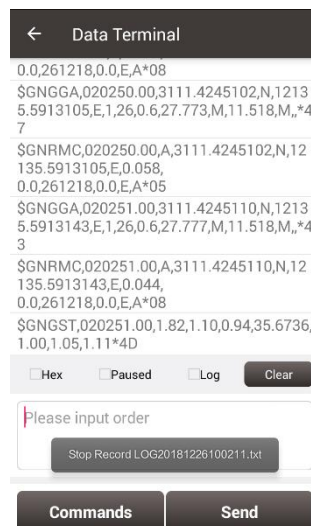


Figure 3.13 Stop recording log data

Click [Clear] to clear the screen.

Click [Commands] to output common NMEA loggings. Check the commands and click [OK], it will return to the command window with the typed commands which is shown in Figure 3.9. Then click [Send] to send the commands to communicate with David receiver.

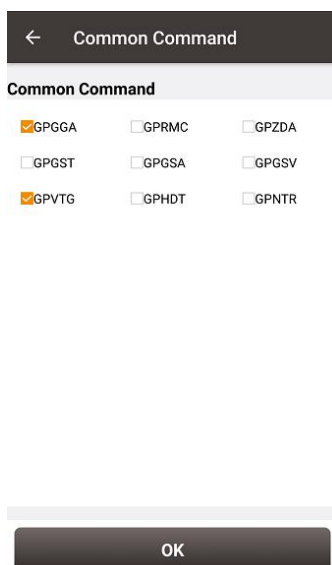


Figure 3.14 Common Command

The detailed description of log and command refers to *Log & Command Reference for Tersus BX GNSS OEM boards* which can be downloaded on Tersus website.



### 3.3 Base

Four default base configurations are provided as in the base main interface. Select a configuration file in the Work Mode List and click [Detail] to edit the base configuration. Click [Start] to complete the base configuration.

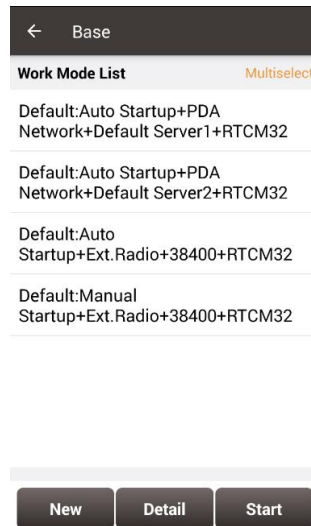


Figure 3.15 Base interface

The base configuration includes: startup mode, data link, antenna height, baud rate and differential format. The details are described as below:

[Startup]: auto start or manual start

- Auto start: the position of the base is achieved automatically.
- Manual start: position points are achieved by averaging collection, loaded from a point library or input manually.

[Ant Height]: antenna type is vertical, slant or pole, antenna height is input manually.

[Data Link]: radio or network

- Radio: the corrections are output / input to / from an external radio, baud rate should be selected accordingly.
- Network: the corrections are uploaded / downloaded to / from a NTRIP host. The IP address, port, password and mount point of the host should be input manually.

[Baud Rate]: can be selected from 9600 to 921600, the default is 38400bps.

[Differential Format]: CMR, CMR+, RTCM2.3 and RTCM3.2 are supported.

The detailed description for each configuration is shown in below screenshots.

Click [New] to create a new base configuration.

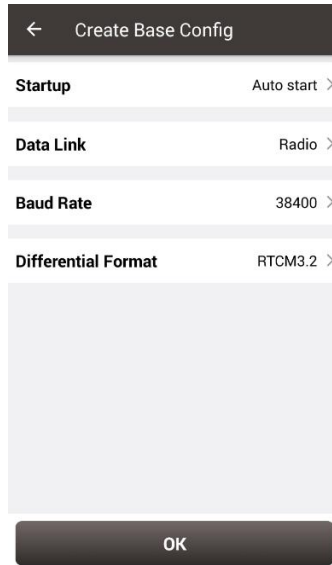


Figure 3.16 Auto start – Radio

In Figure 3.16 above, for auto start in radio mode, baud rate is 38400 by default and can be selected in the pop-up list below. The differential format is RTCM3.2 by default.

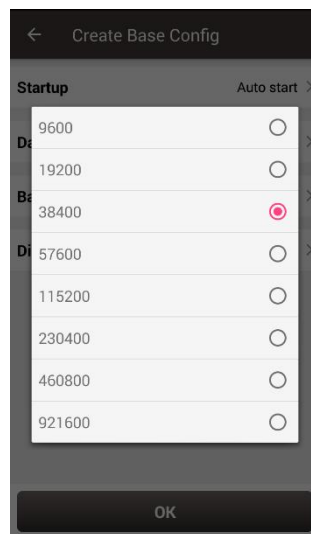


Figure 3.17 Baud rate options

The detailed information of how to use radio refers to *User Manual for David GNSS Receiver*.

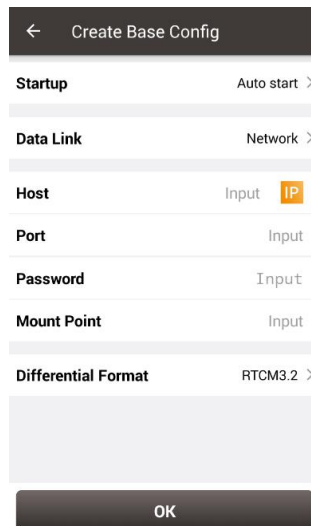


Figure 3.18 Auto start - Network

In Figure 3.18 above, for auto start in network mode, the host can be manually typed or selected by clicking the icon **IP** on the right of row Host. It shows two Ntrip servers built by Tersus GNSS Inc. and can be selected depending on different area. Contact Tersus technical support for password and mount point information if you have bought products from Tersus.



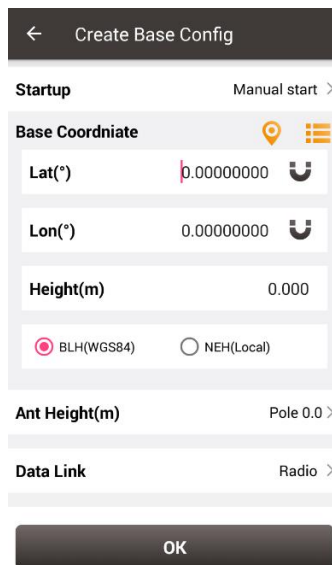
Figure 3.19 Ntrip Site Manager

Ntrip status viewing method when the base station is connected to Ntrip server:

Take asiacaster for example, open any browser on the computer (accessible to internet) and enter the following URL in the address bar:



<http://asiacaster1.tersus-gnss.com:2201/Ntrip.html?usr=username&pwd=password>

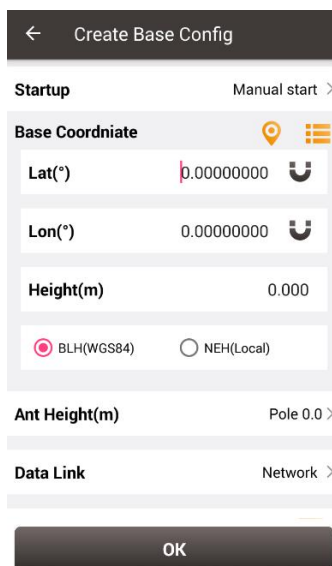
in which, the **username** and **password** should be obtained from Tersus GNSS Inc.



The screenshot shows the 'Create Base Config' screen. At the top, there is a back arrow and the title 'Create Base Config'. Below this, the 'Startup' section is set to 'Manual start'. The 'Base Coordinate' section includes a location icon and a list icon. The 'Lat(°)' field contains '0.00000000', 'Lon(°)' contains '0.00000000', and 'Height(m)' contains '0.000'. There are two radio buttons for coordinate systems: 'BLH(WGS84)' (selected) and 'NEH(Local)'. Below this, 'Ant Height(m)' is set to 'Pole 0.0'. The 'Data Link' section is set to 'Radio'. At the bottom, there is an 'OK' button.

Figure 3.20 Manual start - Radio

In Figure 3.20 above, for manual start in radio mode, the base coordinate should be typed manually or obtained by clicking  the location icon or imported from the survey point library by clicking  the list icon.



The screenshot shows the 'Create Base Config' screen. At the top, there is a back arrow and the title 'Create Base Config'. Below this, the 'Startup' section is set to 'Manual start'. The 'Base Coordinate' section includes a location icon and a list icon. The 'Lat(°)' field contains '0.00000000', 'Lon(°)' contains '0.00000000', and 'Height(m)' contains '0.000'. There are two radio buttons for coordinate systems: 'BLH(WGS84)' (selected) and 'NEH(Local)'. Below this, 'Ant Height(m)' is set to 'Pole 0.0'. The 'Data Link' section is set to 'Network'. At the bottom, there is an 'OK' button.

Figure 3.21 Manual Start - Network

In Figure 3.21, for manual start in network mode, the base coordinate setting is the same with the method mentioned above, the network host setting is the same with the method described for auto start in network mode.

### 3.4 Rover

Three default rover configurations are provided in the Rover main interface. Select a configuration file in the Work Mode List and click [Detail] to edit the rover configuration.

Click [Start] to complete the rover configuration.

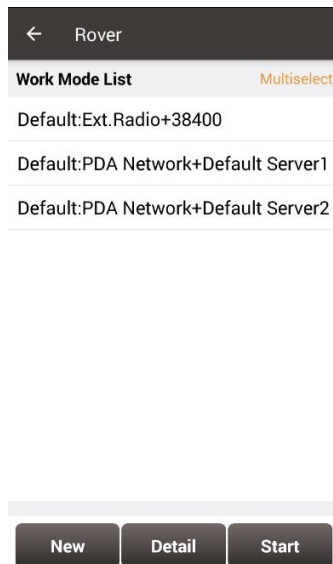


Figure 3.22 Rover interface

The detailed description for each configuration is shown in below screenshots.

Click [New] to create a new configuration.

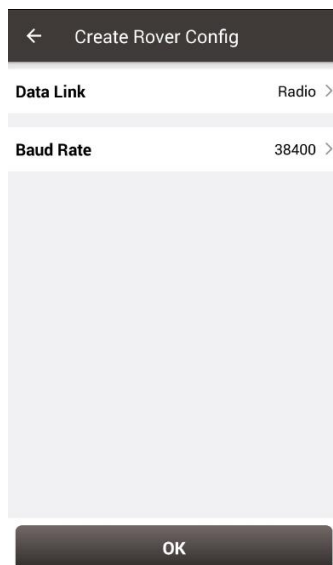


Figure 3.23 Create Rover Configuration - Radio

In Figure 3.23 above, for rover configuration in radio mode, the baud rate is 38400 by default and can be selected from 9600 to 921600 in the pop-up list as shown in Figure 3.17.

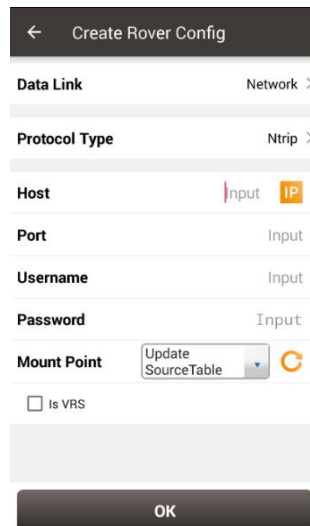


Figure 3.24 Create Rover Configuration – Ntrip Network

In Figure 3.24 above, for rover configuration in network mode, the protocol type can be selected from Ntrip and TCP which is shown below.

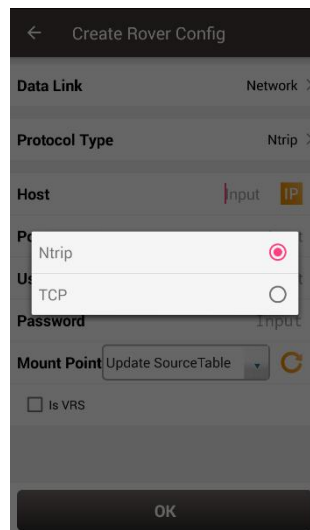




Figure 3.25 Protocol type options

When Ntrip network is selected, the host can be manually typed or selected by clicking the icon  on the right of row Host as mentioned in Figure 3.19 above. The username and password should be obtained from Tersus technical support. The box on the right of Mount Point displays the mount point and differential format after clicking the refresh icon  to update the source table. The example is shown below.

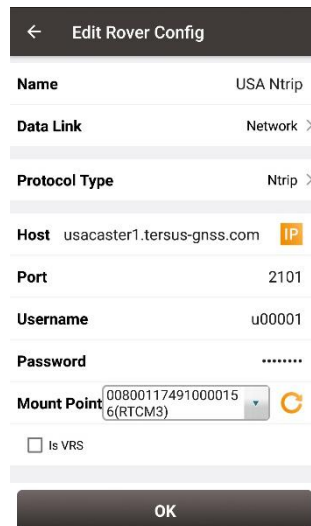


Figure 3.26 Edit Rover Configuration

When TCP is selected for protocol type, fill in the information of host and port according to customer requirements to complete the configuration.

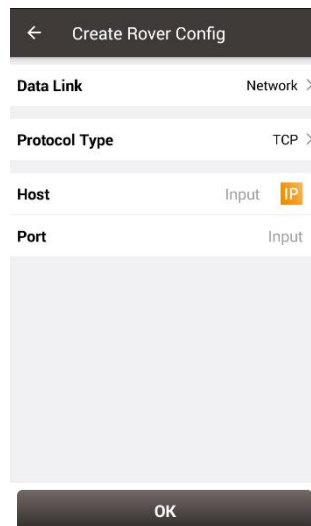


Figure 3.27 Create Rover Configuration – TCP Network

### 3.5 Device Info

Under the Device functional group, click [Device Info] to check the detailed information about the device connected. Click [Reset] or [Register] to complete related operations. Details refer to the descriptions for Figure 1.11 on page 19.

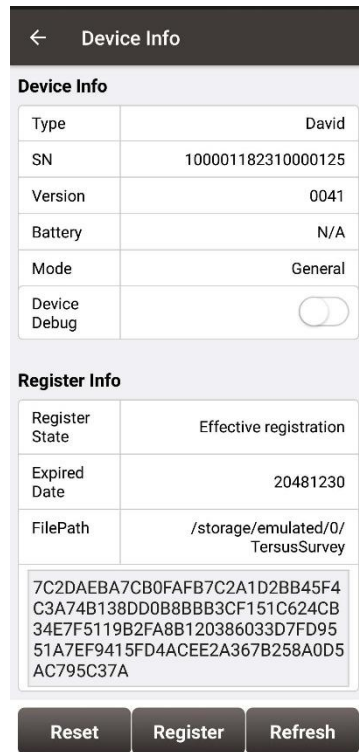


Figure 3.28 Device Info interface

### 3.6 Demo

This module is to be developed.



## 4. Survey

- Point Survey
- Point Stakeout
- Line Stakeout
- Static Survey
- Point Correction
- Survey Config
- Base Shift

## 4.1 Point Survey

The main interface of Point Survey includes: status bar, background map, tools and information.

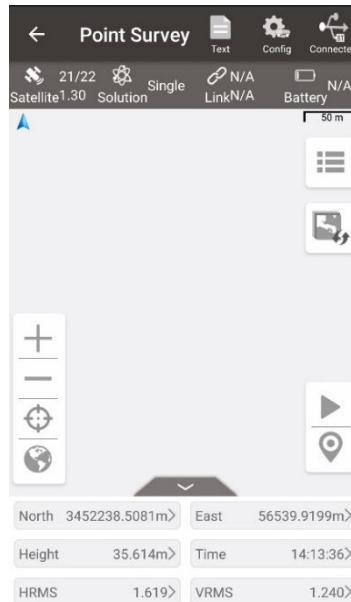


Figure 4.1 Point Survey – Drawing mode

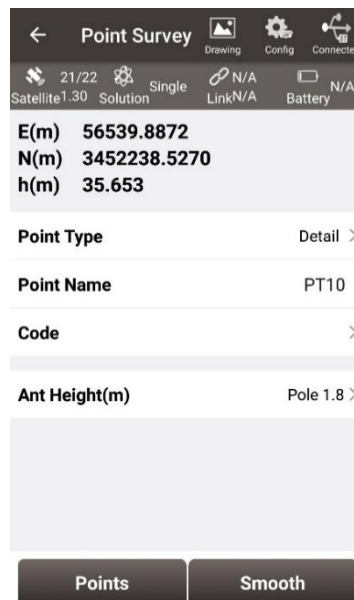


Figure 4.2 Point Survey – Text mode

➤ Status Bar



[Text]: the main interface is shown in text mode or drawing mode, click this icon to switch between the two modes.



[Config]: Survey Configuration, refer to section 4.6 for more details.



[Connected]: connection status with a David receiver, refer to Connect for more details.



[Satellite1.30]: number of satellite traced, e.g., 21 means 21 satellites are used, 22 means 22 satellites are tracked, and 1.30 indicates the PDOP value.



[Solution Fixed]: satellite position type, includes Single, Float, Fixed, DGPS and Base.



[Link1s]: the upper right word indicates the data link type: radio or network; the lower right time is the latency of the data link.



[Battery N/A]: indicates the remaining battery power of Oscar GNSS receiver (when Oscar is released). Currently it is not supported of displaying the battery of David.

➤ Background Map



[Library]: edit the survey point library.



[Map switch]: click it to switch among none, OSM online map and Google online map.



[+]: zoom in the map.



[-]: zoom out the map.



[Zoom to center]: zoom with the current location at the center.



[Map view]: place all the points in one view.

➤ Tools

After survey points are collected, information in blue color is displayed at the up left corner. There are two methods to collect survey points:

[Auto collect]: Auto collect, refer to section 4.6.1 Common Config for more details.

[Manual collect]: Manual collect

➤ Information Bar

Six information items are displayed, each can be chosen from the 18 items in the following screenshots.

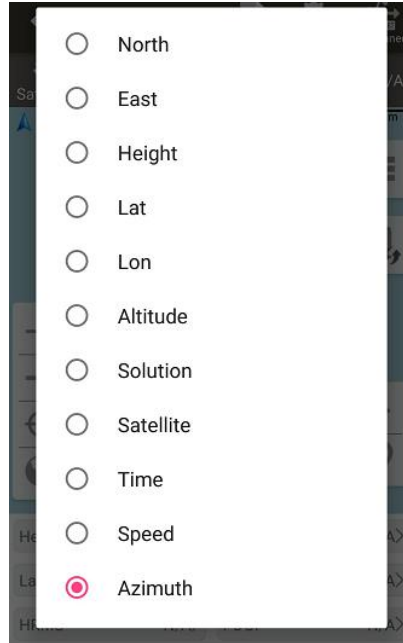


Figure 4.3 Information option list – part 1

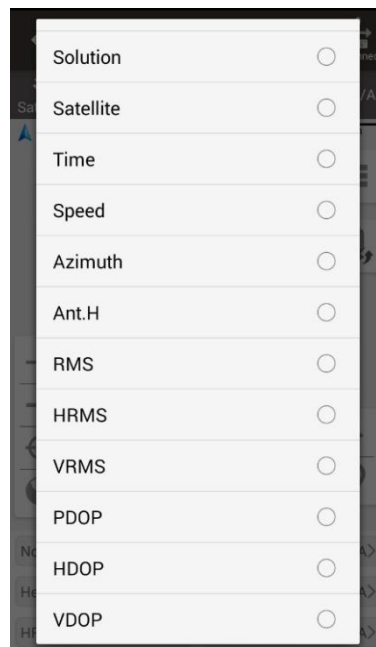


Figure 4.4 Information option list – part 2

## 4.2 Point Stakeout

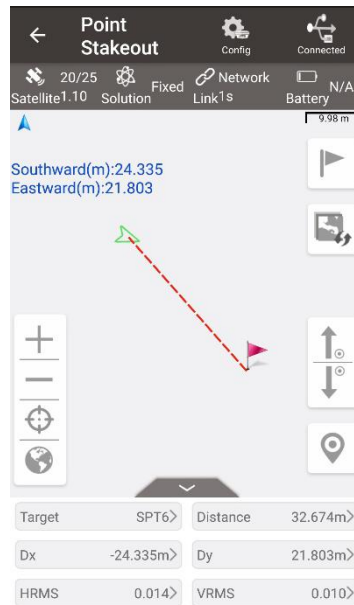





Figure 4.5 Point Stakeout interface

The above screenshot is the main interface of point stakeout, which is similar to that of point survey. The main steps are as follows:

- Add stakeout point: click  to enter the stakeout point library which is shown in Figure 4.6 below, refer to section 2.4 for point library management.
- Select the point to be stakeout: select the point, then click [Select].
- The offset between the current point and the target point is displayed on the screen.

The arrow icons  and  are used to browse the stakeout points in the library.

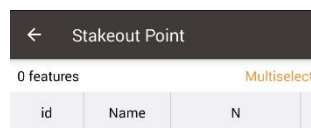


Figure 4.6 Add stakeout point

### 4.3 Line Stakeout

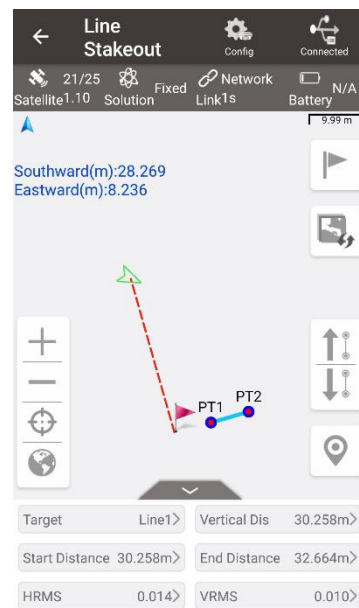





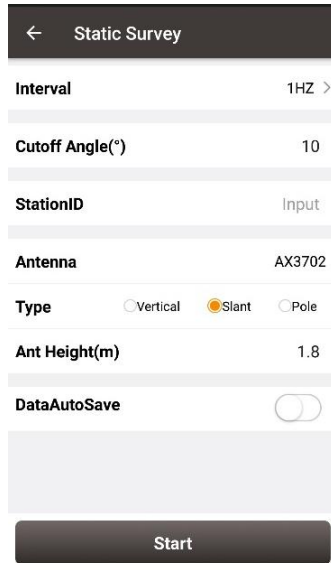
Figure 4.7 Line Stakeout interface

The above screenshot is the main interface of line stakeout, which is similar to that of point survey. The main steps are as follows:

- Click  to enter line stakeout library. Refer to section 2.5.3 for editing line library.
- Select the stakeout line, click [Select].
- The offset between the current point and the target point is displayed on the screen.

The arrow icons  and  are used to browse the stakeout lines in the library.

## 4.4 Static Survey



Field	Value
Interval	1HZ >
Cutoff Angle(°)	10
StationID	Input
Antenna	AX3702
Type	<input type="radio"/> Vertical <input checked="" type="radio"/> Slant <input type="radio"/> Pole
Ant Height(m)	1.8
DataAutoSave	<input type="checkbox"/>

**Start**

Figure 4.8 Static Survey interface

[Interval]: selected from 20HZ, 10HZ, 5HZ, 1HZ, etc. The max rate is determined by the device connected.

[Cutoff Angle]: the cut off angle.

[StationID]: the name of the surveying station.

[Ant Type]: the antenna type.

[Type]: selected from vertical, slant or pole.

[Ant Height]: the height of the antenna.

[DataAutoSave]: when David GNSS receiver is powered on, the static survey data will be saved automatically if this function is turned on.



Figure 4.9 Static data recording

After all the parameters are confirmed, click [Start] to start data collection. The static data is recording as shown in Figure 4.9.

**Note: Static Survey and Device Debug cannot be used at the same time. Please turn off Device Debug as shown in Figure 1.11 manually before recording static data.**



## 4.5 Point Correction

The point correction is to find the mathematical conversion relationship (transition parameter) between WGS84 and the local plane Cartesian coordinate system. There are three calculation types: four-parameter, height-fitting, and four-parameter + height-fitting.

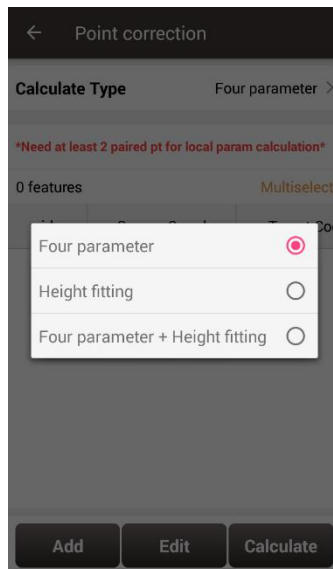


Figure 4.10 Calculation Type options

There are three methods for height-fitting: fixed difference correction, plane fitting and surface fitting.

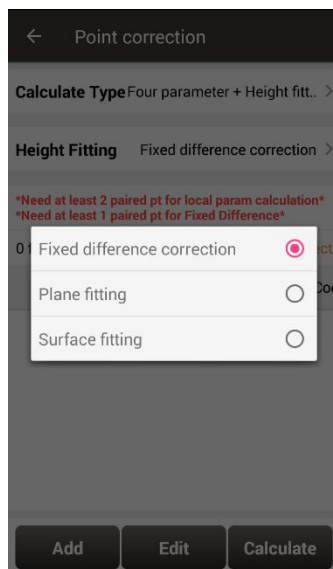


Figure 4.11 Height Fitting options

#### 4.5.1 Four Parameter

At least two paired points are needed for Four Parameter type. Click [Add] to input the original coordinate values and the target coordinate values. Refer to section 2.4 about how to add points in the library.

#### 4.5.2 Height Fitting

The number of points is different when different height fitting methods are used, the details are as follows:

*Fixed Difference Correction*: at least one paired point is needed.

*Plane Fitting*: at least three paired points are needed.

*Surface Fitting*: at least six paired points are needed.

Refer to section 2.4 about how to add points in the library.

#### 4.5.3 Four Parameter + Height Fitting

The number of points is different when different height fitting methods are used, the details are as follows:

*Fixed Difference Correction*: at least two paired points for local parameter calculation and one paired point for fixed difference are needed.

*Plane Fitting*: at least two paired points for local parameter calculation and three paired points for plane fitting are needed.

*Surface Fitting*: at least two paired points for local parameter calculation and six paired points for surface fitting are needed.

Refer to section 2.4 about how to add points in the library.

#### 4.5.4 Application Example

This section introduces an example of a calculation when Four Parameter + Height Fitting is selected for Calculate Type and Fixed Difference Correction is selected for Height

Fitting.

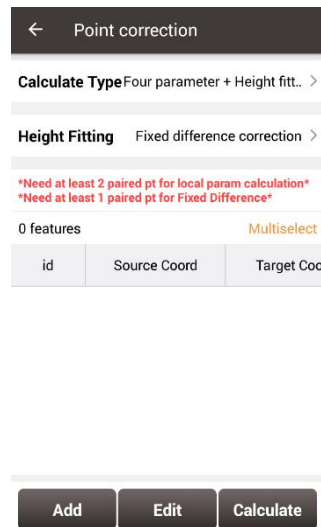


Figure 4.12 Application example for point correction

Click [Add] to add point for source coordinate and target coordinate.

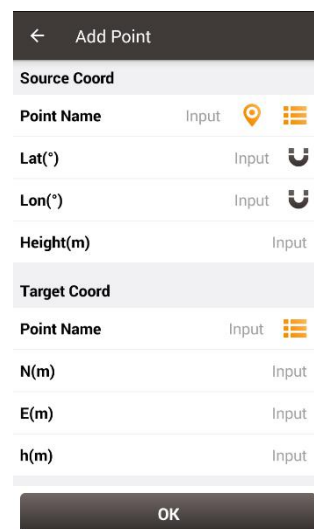





Figure 4.13 Add point for point correction

The source coordinate can be typed manually or obtained by clicking  the location icon or imported from the survey point library by clicking  the list icon.

The target coordinate can be typed manually or imported from the survey point library by clicking  the list icon.

In this example, two pairs of points are type manually for calculation, which are shown below.

← Add Point

**Source Coord**

Point Name e006

Lat(°) 31.19889139

Lon(°) 120.71634815

Height(m) 3.914

**Target Coord**

Point Name e006

N(m) 3453071.676

E(m) 496716.053

h(m) 1.974

OK

Figure 4.14 The 1st pair of points for calculation

← Add Point

**Source Coord**

Point Name e007

Lat(°) 31.20232084

Lon(°) 120.72919000

Height(m) 4.025

**Target Coord**

Point Name e007

N(m) 3453451.621

E(m) 497939.999

h(m) 2.054

OK

Figure 4.15 The 2nd pair of points for calculation

Click [OK] and two pairs of points are shown below.

← Point correction

**Calculate Type** Four parameter + Height fit. >

**Height Fitting** Fixed difference correction >

*\*Need at least 2 paired pt for local param calculation\**  
*\*Need at least 1 paired pt for Fixed Difference\**

2 features Multiselect

id	Source Coord	Target Coord
1	B:31.198891390 L:120.716348150 H:3.9140	N:3453071.6760 E:496716.0530 H:1.9740
2	B:31.202320840 L:120.729190000 H:4.0250	N:3453451.6210 E:497939.9990 H:2.0540

Add Edit Calculate

Figure 4.16 Two pairs of points for calculation

Click [Calculate] and the data is calculated with the result shown below.

← Result:

**Local Para Result:**

dDX(m) : 89.3786    dDY(m) : -7.7020

Rotation Angle : 3.1718797057

Scale : 0.9999680227

---

**Height Fitting Result:**

A0: 106.76839    A1: 0.00000

A2: 0.00000    A3: 0.00000

A4: 0.00000    A5: 0.00000

---

Max.HRMS            0.0000    NO.: 1

---

Max.VRMS            0.0154    NO.: 1

Cancel            Apply

Figure 4.17 Calculation Result

Click [Apply] to apply the point correction result to the current project coordinate system, and it prompts that 'Apply result successfully!'.

← Point correction

**Calculate Type** Four parameter + Height fitt.. >

---

**Height Fitting** Fixed difference correction >

*\*Need at least 2 paired pt for local param calculation\**  
*\*Need at least 1 paired pt for Fixed Difference\**

2 features Multiselect

id	Source Coord	Target Coor
1	B:31.198891390 L:120.716348150 H:3.9140	N:3453071.6760 E:496716.0530 H:1.9740
2	B:31.202320840 L:120.729190000 H:4.0250	N:3453451.6210 E:497939.9990 H:2.0540

Apply result successfully!

Add    Edit    Calculate

Figure 4.18 Point correction results applied to current project

Slide left of the title bar to view the values of Residual results as shown below.

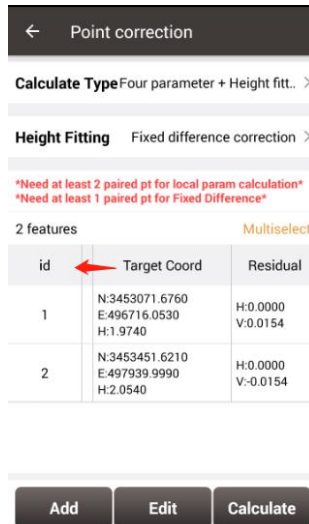


Figure 4.19 Slide left to view residual results

The results applied to the current project coordinate system can be checked in Project Property interface below.

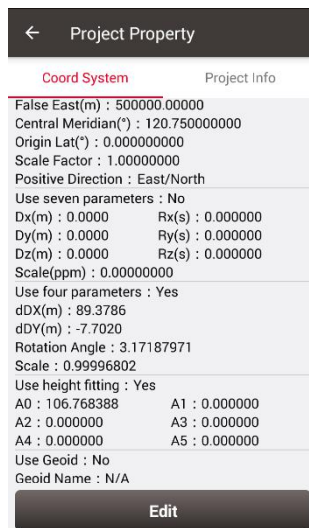


Figure 4.20 Updated project property after point correction

## 4.6 Survey Config

During data collection, restrictions are given to solution type and HRMS limits, hence only the data meeting the restrictions can be saved. More details are as follows:

### 4.6.1 Common Config

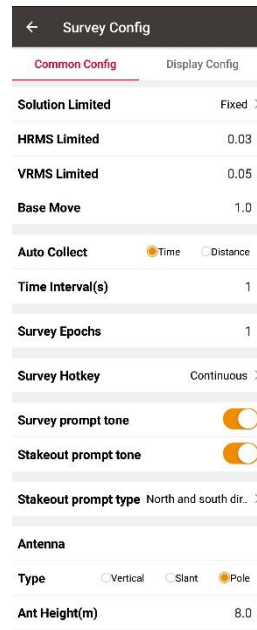


Figure 4.21 Survey Config – Common Config

[Solution Limited]: includes Single, DGPS, SBAS, Float and Fixed. The solution accuracy (from high to low) is: Fixed > Float > SBAS > DGPS > Single.

[HRMS Limited]: horizontal RMS limit. Data would not be collected if its HRMS is greater than this limit.

[VRMS Limited]: vertical RMS limit. Data would not be collected if its VRMS is greater than this limit.

[Base Move]: If the base moves over this limit, the data collection would not be finished.

[Auto Collect]: data can be collected according to Time or Distance.

If Time is selected, ensure to input the time interval.

If Distance is selected, ensure to input the distance interval.

[Smooth Epochs]: smooth epoch can be 2, 3, 5 or 10 seconds.

[Survey Prompt Tone]: can be enable or disabled.

[Stakeout Prompt Tone]: can be enable or disabled.

[Stakeout Prompt Type]: can be North and South direction or Forward and Backward.

[Ant Type]: Antenna parameters.

[Type]: height type, can be vertical, slant or pole.

[Ant Height]: value of the antenna height.

#### 4.6.2 Display Config

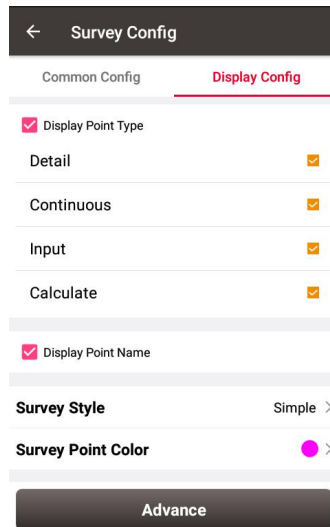


Figure 4.22 Survey Config – Display Config

Select the Display Point Type and Display Point Name according to the application.

Select Survey Style: Simple or Detailed.



Figure 4.23 Survey Point Color

Click [Survey Point Colour] to select a colour on the outer ring for the survey points and click the inner pie to confirm the colour.



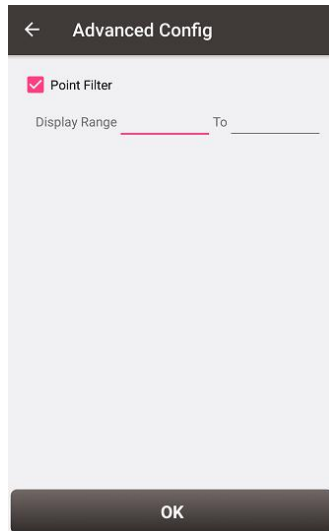


Figure 4.24 Advanced Config for Display Config

Click [Advance] to filter the displayed points.

## 4.7 Base Shift

In 'Auto Start' mode for base station, if the base is moved, re-erected or restarted at an unknown point, base shift should be performed to ensure the points collected by the current base station is consistent with that before the base is moved or powered off. Briefly, find a known point, measure the coordinates of this point, then use this point to calculate the offset of the base shift, apply the base shift to all the survey points under the current base coordinates to make the reference coordinate system of the base remains the same as the previous base station.

The detailed steps are as follows:

Click [Base Shift] to enter the following interface, Figure 4.25 shows the calculation result for the base shift; Figure 4.26 shows the source of the base shift calculation. Click the list icon on the right of GNSS Point to select a survey point which is measured at the known point and click the list icon on the right of Known Point to select a known point in the control point library (details of control point refers to section 2.4 Point). Click [Calculate] and the base shift is calculated automatically. Click [Apply] to apply the base shift to all the points surveyed and to be surveyed under the current base station.

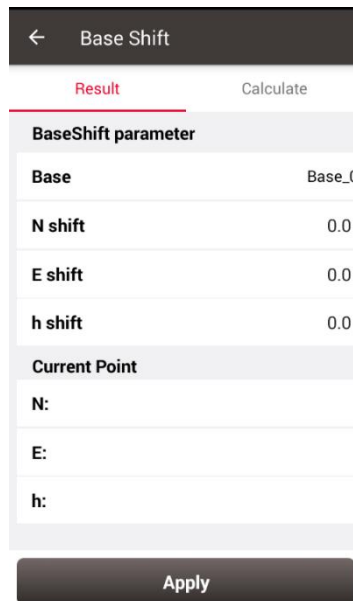


Figure 4.25 Base Shift interface – 1

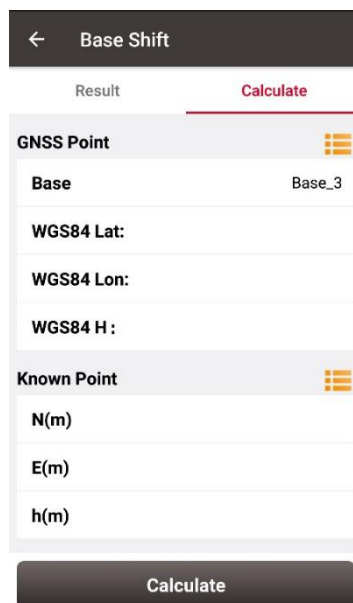


Figure 4.26 Base Shift interface – 2

## 5. Tools

- Area Perimeter
- Distance Calculation
- Offset Point
- Rotation Point
- Two Points Intersection
- Four Points Intersection
- Azimuth
- Intersection Angle

## 5.1 Area Perimeter

This tool is used to calculate area and perimeter. The points can be imported from the point library by clicking the list icon on the upper right corner. The unit is meter for perimeter and square meter for area.

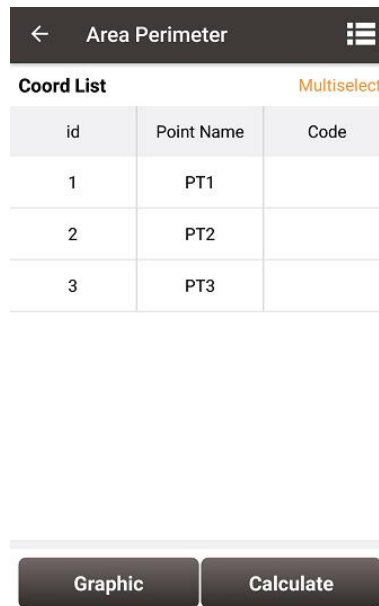


Figure 5.1 Area Perimeter interface

[Graphic]: shows the closed polygon formed by the points.

[Calculate]: calculates the area and perimeter of the closed polygon.

[Multiselect]: enters point edit interface to inverse or delete.

**Note: The calculation results are all plane results (point elevation does not participate in the calculation). It is suitable for all sections in this chapter except section 5.3 Offset Point.**

## 5.2 Distance Calculation

There are two kinds of distance calculation: point to point, and point to line. The points can be imported from the point library.

### 5.2.1 Point to Point Distance

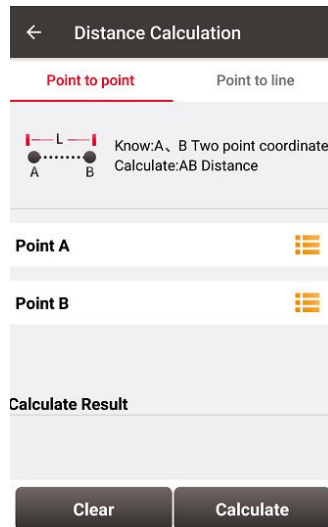


Figure 5.2 Distance Calculation – Point to Point

Import point A and point B from the point library.

[Calculate]: calculate the distance between the two points.

[Clear]: clear the result.

### 5.2.2 Point to Line Distance

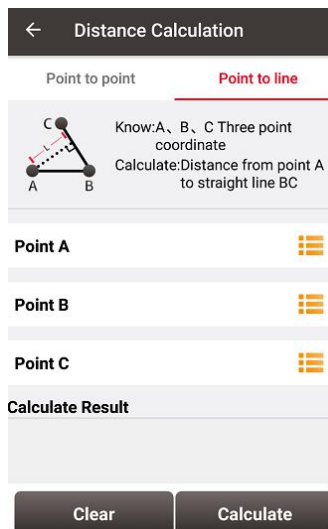


Figure 5.3 Distance Calculation – Point to Line

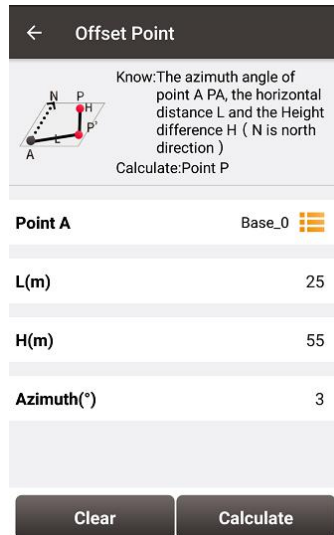
Import a point from the library to calculate the distance from point A to line BC.

[Calculate]: calculate the distance.

[Clear]: clear the result.

### 5.3 Offset Point

Given point A, AP's horizontal length L and height H, calculate the coordinate of P. The steps are as follows:



← Offset Point

Know: The azimuth angle of point A PA, the horizontal distance L and the Height difference H ( N is north direction )  
Calculate: Point P

Point A Base\_0

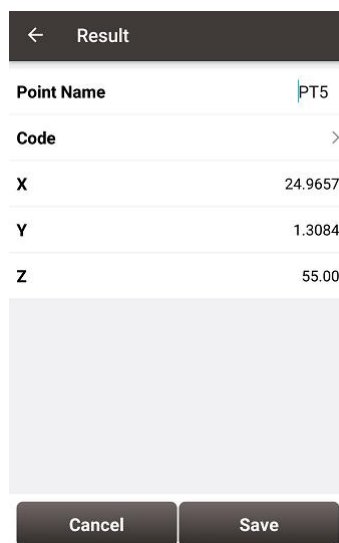
L(m) 25

H(m) 55

Azimuth(°) 3

Clear Calculate

Figure 5.4 Offset Point interface



← Result

Point Name PT5

Code >

X 24.9657

Y 1.3084

Z 55.00

Cancel Save

Figure 5.5 Offset Point calculation result

[Calculate]: calculate the coordinate of point P.

[Clear]: clear the current result.

## 5.4 Rotation Point

Given the coordinates of point A, B and the rotation angle (clockwise), calculate the coordinate of point B after rotation.

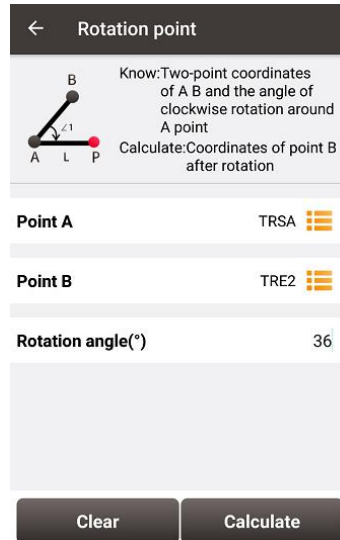


Figure 5.6 Rotation Point interface

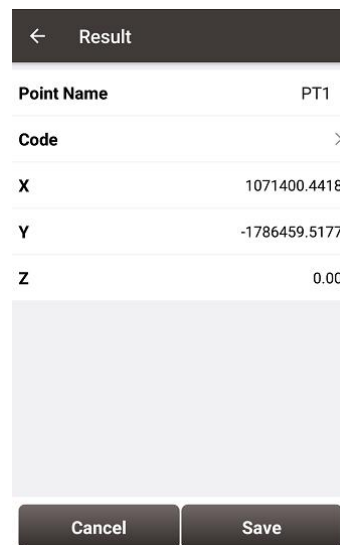


Figure 5.7 Rotation Point Calculation result

[Calculate]: calculate the coordinate of point B after rotation.

[Clear]: clear the result.

## 5.5 Two Points Intersection

There are two types of models listed below:

- Model 1: Given the coordinates of point A and B, the angle  $\alpha$  between line AB and AP, the angle  $\beta$  between line AB and BP, calculate the coordinate of point P.
- Model 2: Given the coordinates of point A and B, the length of line AB and PB, calculate the coordinate of point P.

Figure 5.8 Two Point Intersection – Angle

Figure 5.9 Two Point Intersection – Distance

[Calculate]: calculate the coordinate of the intersection P.

[Clear]: clear the result.



## 5.6 Four Points Intersection

Given line AB and CD, calculate the coordinate of the intersection point P.

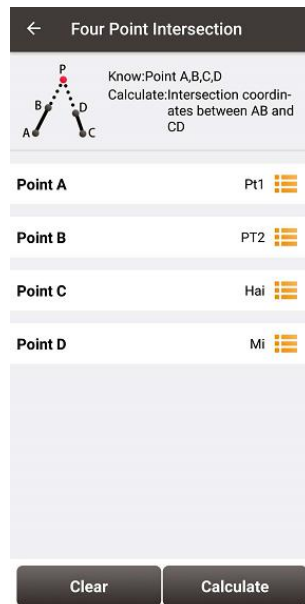


Figure 5.10 Four Point Intersection interface

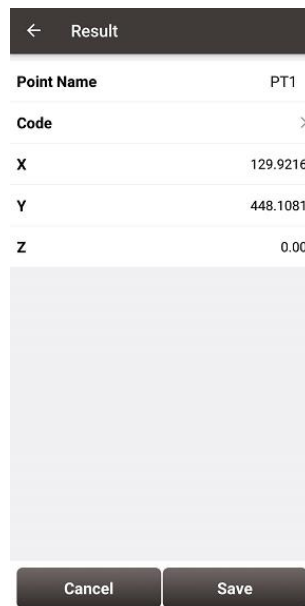


Figure 5.11 Four Point Intersection result

[Calculate]: calculate the coordinate of the intersection P.

[Clear]: clear the result.

## 5.7 Azimuth

Given the coordinates of point A and B, calculate the heading angle of line AB.

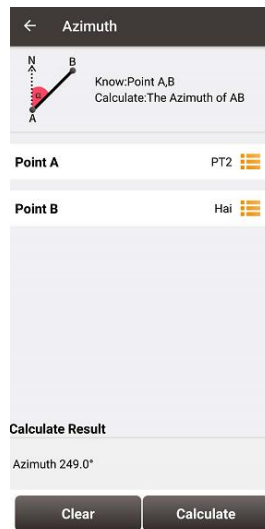


Figure 5.12 Azimuth calculation interface

[Calculate]: calculate the heading of line AB.

[Clear]: clear the result.

## 5.8 Intersection Angle

Given the coordinates of point A, B and C, calculate the angle  $\angle ABC$

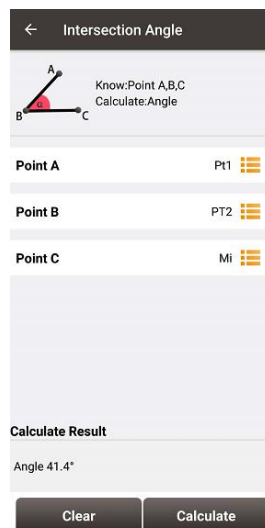


Figure 5.13 Intersection Angle calculation

[Calculate]: calculate the angle  $\angle ABC$ .

[Clear]: clear the result.

## 6. TC20 Controller and application

### 6.1 Overview of TC20 Controller

The Tersus TC20 Controller is a rugged smart phone with design of 4.3" touch screen and an alphanumerical keypad. Equipped with powerful processor, it is perfect to adapt with Tersus Survey software. With professional IP67 rating, it is robust and reliable for harsh operating conditions.

#### Features:

- Rugged smart phone 4.3" display
- 4G GSM unlocked Android 6.0
- Quad-Core 1.3GHz CPU
- 2GB RAM + 16GB ROM
- 8 MP Auto Focus camera
- IP67 certified grade, water/shock/dust proof
- 6500 mAh battery
- A-GPS supported
- Wi-Fi, Bluetooth, NFC
- Two color options: red and yellow

***Note: Although the TC20 controller uses chemical and impact resistant materials, precision instruments require careful use and maintenance and should be kept as dry as possible. In order to improve the stability and life cycle of the TC20 controller, avoid exposing the TC20 controller to extreme environments such as moisture, high temperatures, low temperatures, corrosive liquids or gases.***



TC20 must be in the specified temperature range  $-20^{\circ}\text{C} \sim 55^{\circ}\text{C}$  when used and stored.

## 6.2 Outlook of TC20 Controller

**Power on:** Press and hold the power button for 3 seconds

**Power off:** Press and hold the power button for 3 seconds, select 'power off' in the menu option.



Figure 6.1 Four sides of TC20 controller

**Menu Key:** Select to show the available menu in current screen.

**Home Key:** Return to home screen. To view recent application, press and hold the home key.

**Back Key:** Return to previous screen.

**Volume Key:** Adjust the volume of the ringtone.

**Reset Key:** Shut down the phone when phone is abnormal.

**Camera key:** Short press to enter camera in home screen. Long press it to open torch.

### 6.3 Accessories of TC20 Controller

Charger (5V/1A)



Figure 6.2 Charger

Lithium Battery (3.7V/6500mAh)



Figure 6.3 Lithium Battery

Mini USB cable



Figure 6.4 Mini USB cable

- Functions:
1. Connect to the USB port of computer for data downloading;
  2. Connect to the charger to charge TC20 controller.

## 6.4 General Operations

### 6.4.1 Insert SIM card and T-Flash card

1. **Remove the back cover:** Loosen the screws on the back side – to rotate the screws anti-clockwise until open the back cover as shown in Figure 6.5.



Figure 6.5 Remove the back cover

2. **Take off the back cover:** Remove the back cover by lifting it up from the bottom part as shown in Figure 6.6.

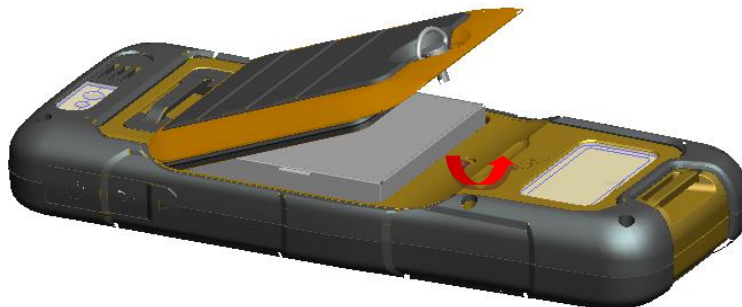


Figure 6.6 Take off the back cover

3. **Put the SIM Card in the holder:** Put the SIM card into the slot touching the SIM contacts of the phone as shown in Figure 6.7.

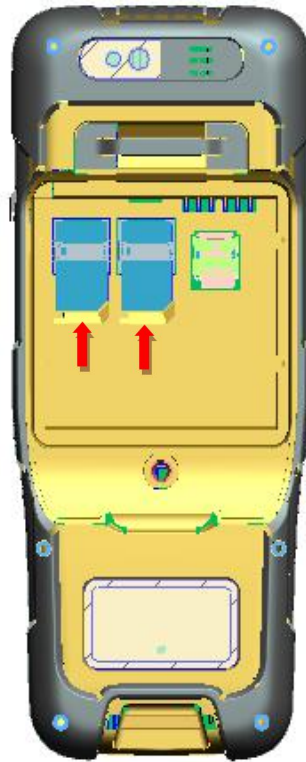


Figure 6.7 Put the SIM card in the holder

4. **Insert T-Flash card:** Open T-Flash card holder and insert T-Flash card into the slot, then close T-Flash card holder as shown in Figure 6.8.

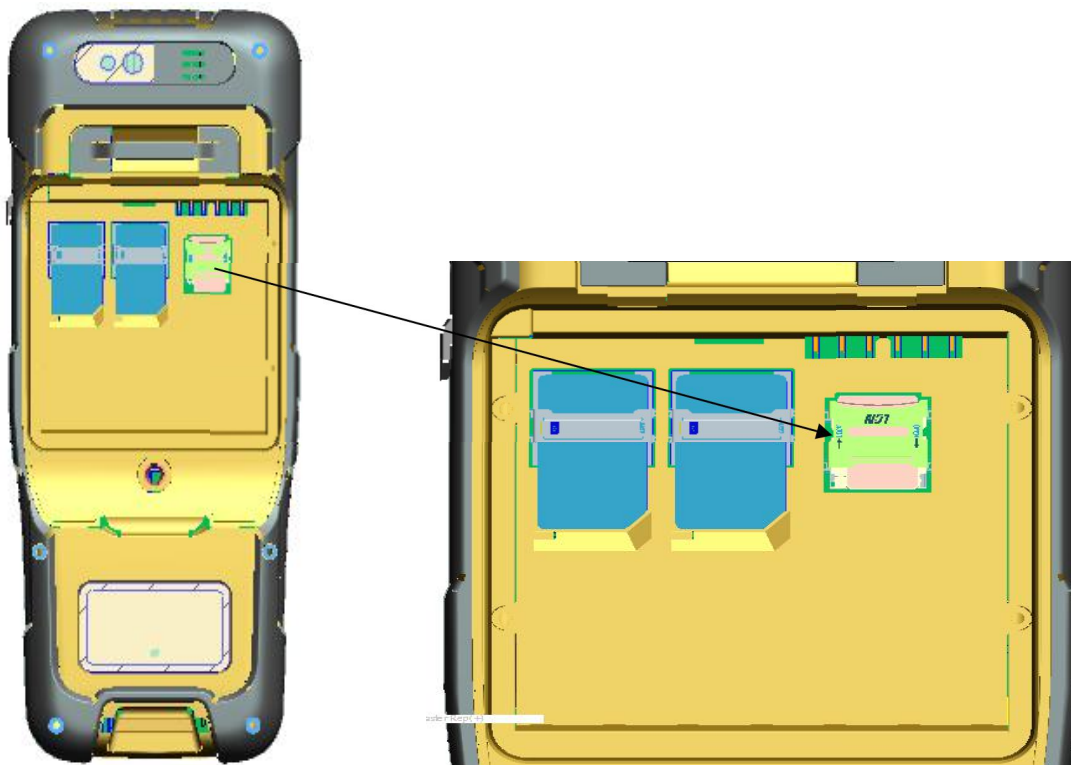


Figure 6.8 Insert T-Flash card

5. **Insert the back cover:** Insert the back cover and rotate screws clockwise to lock the back cover as shown in Figure 6.9.



Figure 6.9 Insert the back cover

***Note: Please power off the phone before plug in or pull out the SIM card.***

#### 6.4.2 T-Flash card

1. Connect USB, turn on USB storage.  
It automatically pops up USB connected interface after connecting USB, and then click Turn on USB storage to use the T-Flash as USB storage.



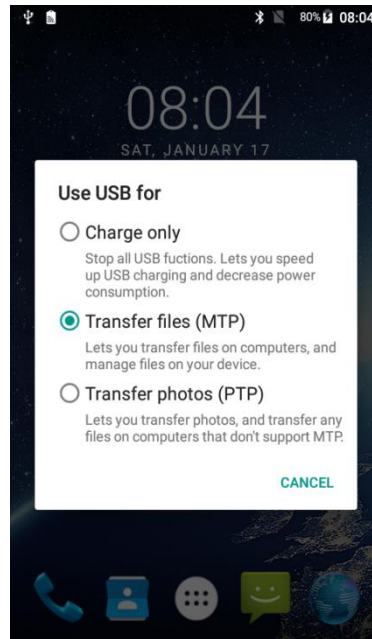


Figure 6.10 Select USB function

### 6.4.3 Using of Touch Screen

**Single Click:** To select an icon. For example, click dial to open the keypad which will be displayed on the screen.

**Double Click:** To zoom-in or zoom-out. For example, to zoom-in or out of a photo, click twice when viewing a photo or browsing on the internet.

**Hold:** Click and hold the screen, icon or input box to get more operation options.

- 1) Long-Time Click a picture in the gallery list interface, the status bar prompts to select a picture, you select to share or delete.
- 2) Long-Time Click the blanks of home screen to add home screen shortcut.
- 3) Long-Time Click the blanks of home screen wallpaper sources can be selected.

**Drag the screen:** You can drag the screen to view more applications which are not displayed in one screen.

**Scratch the screen:** A screen of information cannot be displayed scratch scrolling display hidden information.


## 7. Technical Appendix

### 7.1 Quick Start

#### 1. Create a new project

Go to [Project] -> [Project], click [New], input the project name, select a CRS or edit with a template CRS, click [OK] to create a project.

#### 2. Connect a device

Go to [Device] -> [Connect], select the device type, connect type, connect config and antenna type, and click [Connect]. Click  in the status bar can also connect to the device.

#### 3. Configure the base and the rover

A base transmits RTK corrections to an external radio or to network. The position of the base must be input manually or auto start. Nuwa supports RTK uploading to a NTRIP host, which brings convenience for a number of applications.

A rover receives RTK corrections from an external radio or from network. NTRIP and TCP protocols are supported if corrections are received from network.

All the configuration can be managed, such as created, edited and deleted in Nuwa App. A device can be configured to work as a base or as a rover.

#### 4. Point Correction and Base Shift

The point correction is to find the mathematical conversion relationship (transition parameter) between WGS84 and the local plane Cartesian coordinate system. There are three calculation types: four-parameter, height-fitting, and four-parameter + height-fitting.

There are three methods for height fitting: Fixed Difference Correction, Plane Fitting and Surface Fitting.

In Auto Start mode, if a base is moved or re-installed, Base Shift is necessary to make the points have the same coordinates before and after the power cycle. Main steps:

Go to [Survey] -> [Base Shift], select GNSS points and known points, click [Calculate], the offsets parameters are calculated automatically. The user can apply the parameters on the points to be surveyed. Base Shift also influence coordinates value of other points with this base.

Steps 5 - 8 are action points in fields, select one or more in fields.

#### 5. Point Survey

Go to [Survey] -> [Point Survey] to enter survey interface, which can be in text mode or drawing mode. The main difference between the two modes is whether the drawing is displayed. The configuration refers to section 4.6.1 Common Config for more details.

Two collection modes: Auto Collect and Manual Collect, refer to section Point Survey for details. All the detailed information about the survey points can be checked in the survey point library.

#### 6. Point Stakeout

Go to [Survey] -> [Point Stakeout] to enter point stakeout interface. Stakeout points must be saved in the stakeout point library before. Select the points to be stakeout and find the target point according to the prompt information by Nuwa, refer to sectionn Point Stakeout for details.

#### 7. Line Stakeout

Go to [Survey] -> [Line Stakeout] to enter line stakeout interface. Stakeout lines muse be saved in the stakeout line library. Select the lines to be stakeout and find all the points on the target line according to the prompt information by Nuwa, refer to section Line Stakeout for details.

#### 8. Static Survey

Go to [Survey] -> [Static Survey] to enter static survey interface. Select the parameters, such as interval, cut off angle, antenna parameters and click [Start], refer to section Static Survey for details.

## 9. Export

Go to [Project] -> [Export] to enter export interface. Four file formats are supported: csv, dxf, shp and kml. The data to be exported can be filtered by point type and collection time. Click [Start] after all the options are filled.

## 10. Import

Go to [Project] -> [Import] to enter import interface, which can be divided into Coordinate Import and Other Import.

Coordinate import is to import points in a CSV file, mainly to import points to a library.

Other import is to import the DXF or SHP files for the background. Click [File Path] to input the file directory.

## 7.2 Static Data Process with David

### 7.2.1 Preparation

- A David GNSS receiver
- A DC-2pin to USB power cable
- A COMM2-7pin to USB & DB9 cable
- A power bank
- A computer running TersusDownload tool



Figure 7.1 Preparation for Static Data Process

After the static survey in fields is completed, connect the David receiver to the computer according to the following figure and power on the David receiver.

The USB port is mapped to a serial port (COM5 in the following example) in the computer, which can be checked in the Device Manager.



Figure 7.2 Connections of David, computer and power bank

### 7.2.2 File Downloading

It is recommended to type UNLOGALL in the command window of Tersus GNSS Center software before executing below steps. Open the TersusDownload on the computer, select the serial port to communicate with the David receiver.

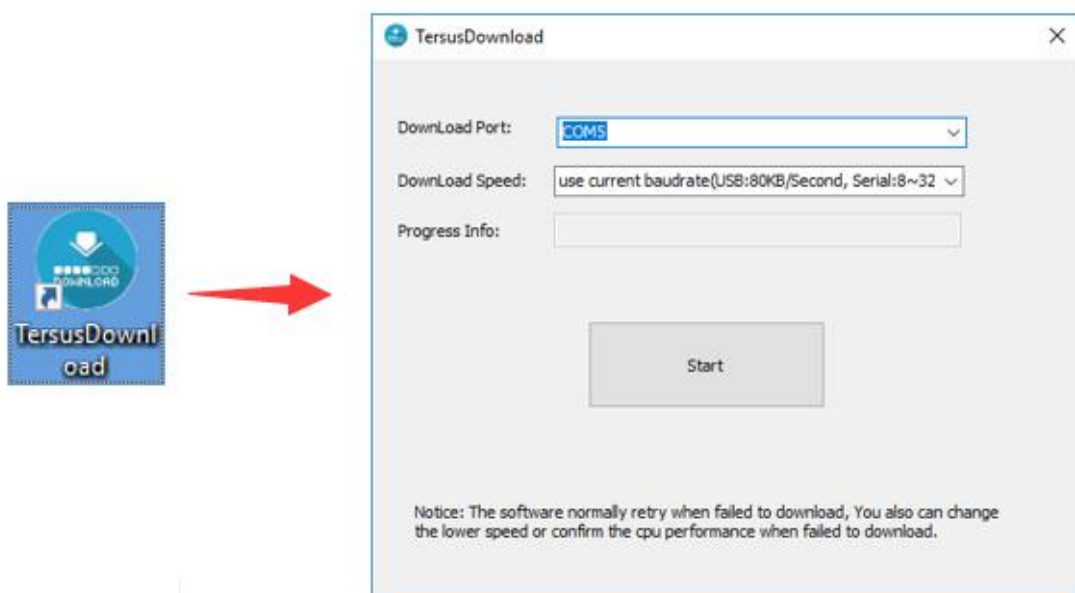


Figure 7.3 TersusDownload interface

Select the download speed. Select 'use current baudrate' when using USB port to download files as shown below. Select baud rate 460800bps if a serial port is used to download files.

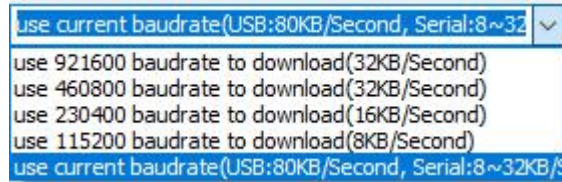


Figure 7.4 Download speed options

After completing the above steps, click [Start] and it pops out below window. Select the DownloadPath, select the files to be downloaded, click [Download] to start downloading:

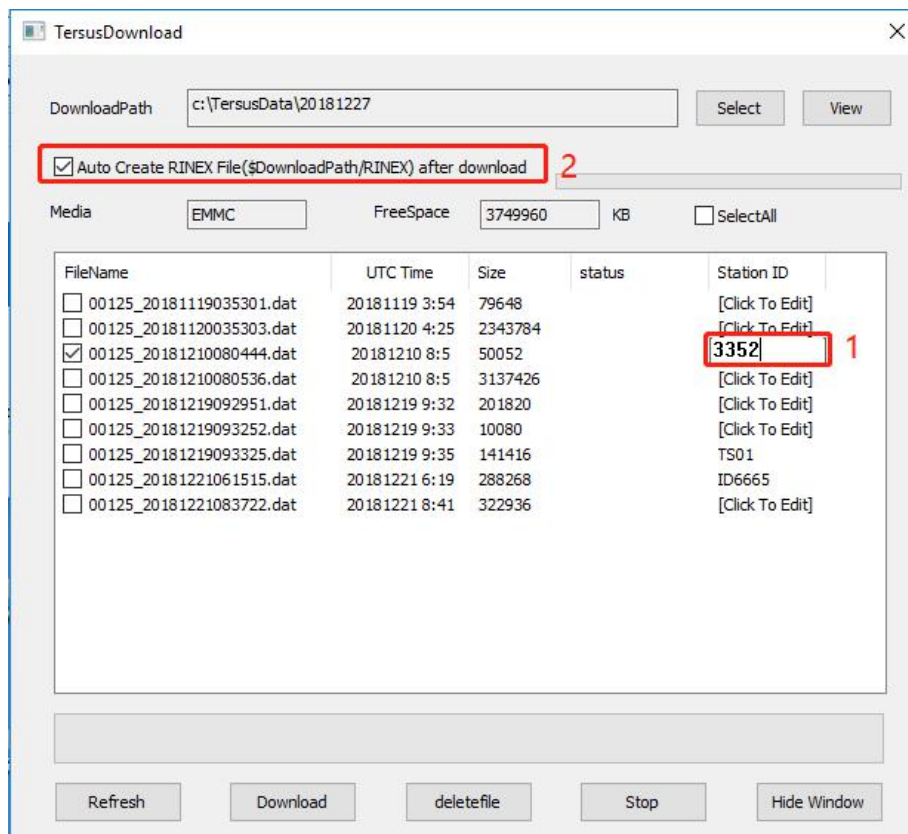


Figure 7.5 File selected for download

In this interface, click the number in red box 1 to edit Station ID if necessary, or it can be edited in Figure 4.8 in section 4.4 Static Survey. Check the box in the left of red box 2 to enable or disable auto create RINEX file after download.

!	The downloading rate is about 2MB/min, the downloading time can be estimated based on it.
!	It is recommended to ensure the computer has available CPU and memory when

downloading files.

Open the RINEX file using notepad or other text viewing software, the antenna height is vertical height which is from the phase center of the antenna to the point on the ground. The value of the antenna height can be found as shown below.

```

3.02 OBSERVATION DATA M (MIXED) RINEX VERSION / TYPE
Tersus Tersus 2019-03-19 10:12 PGM / RUN BY / DATE
Test MARKER NAME
Tersus Tersus MARKER NUMBER
OBSERVER / AGENCY
REC # / TYPE / VERS
ANT # / TYPE
APPROX POSITION XYZ
-2860990.0400 4651726.0655 3283992.2949 ANTENNA: DELTA H/E/N
1.0375 INTERVAL
1.0000 SYS / # / OBS TYPES
G 8 C1C L1C D1C S1C C2P L2P D2P S2P SYS / # / OBS TYPES
C 8 C1I L1I D1I S1I C7I L7I D7I S7I SYS / # / OBS TYPES
R 8 C1C L1C D1C S1C C2P L2P D2P S2P SYS / # / OBS TYPES
2019 3 19 9 38 19.0000000 GPS TIME OF FIRST OBS
2019 3 19 10 12 3.0000000 GPS TIME OF LAST OBS
END OF HEADER
> 2019 03 19 09 38 19.0000000 0 24
G01 20477692.414 107611001.758 1744.113 46.000 20477694.438 83852737.918 1359.066 47.000
G07 20644342.445 108486749.574 -771.430 46.000 20644342.602 84535126.090 -601.168 44.000
G08 21771518.555 114410099.551 -1845.258 45.000 21771520.914 89150736.824 -1437.852 43.000
G11 20218292.344 106247839.395 437.070 44.000 20218290.375 82790516.031 340.543 39.000
G16 24614137.047 129348152.883 -2549.102 35.000 24614137.047 100790757.469 -1986.465 20.000
G18 20084844.078 105546570.480 -180.441 45.000 20084844.602 82244079.199 -140.668 39.000
G22 23999749.844 126119558.992 2465.613 38.000 23999748.195 98274979.070 1921.180 26.000
G27 24046037.734 126362774.551 -2662.340 38.000 24046039.195 98464502.613 -2074.566 39.000
G28 23831380.477 125234751.008 2417.512 40.000 23831378.719 97585516.570 1883.742 25.000
G30 21610795.938 113565496.465 1380.316 45.000 21610798.203 88492604.246 1075.527 43.000
C01 36967716.523 192500600.000 10.000 44.000 36967709.789 148853647.844 7.664 47.000
C02 38306562.961 199472321.852 20.707 39.000 38306558.727 154244635.484 16.035 44.000
C03 36909363.773 192196740.523 6.414 45.000 36909361.086 148618701.039 4.969 46.000
C04 38123486.313 198518996.797 15.398 42.000 38123483.750 153507470.684 11.938 45.000
C07 35729677.038 186053801.026 245.375 46.000 35729677.734 143868586.386 189.785 47.000
    
```

Figure 7.6 View antenna height in the RINEX file

### 7.2.3 Data Post Processing

Open TERSUS Geo Office software:

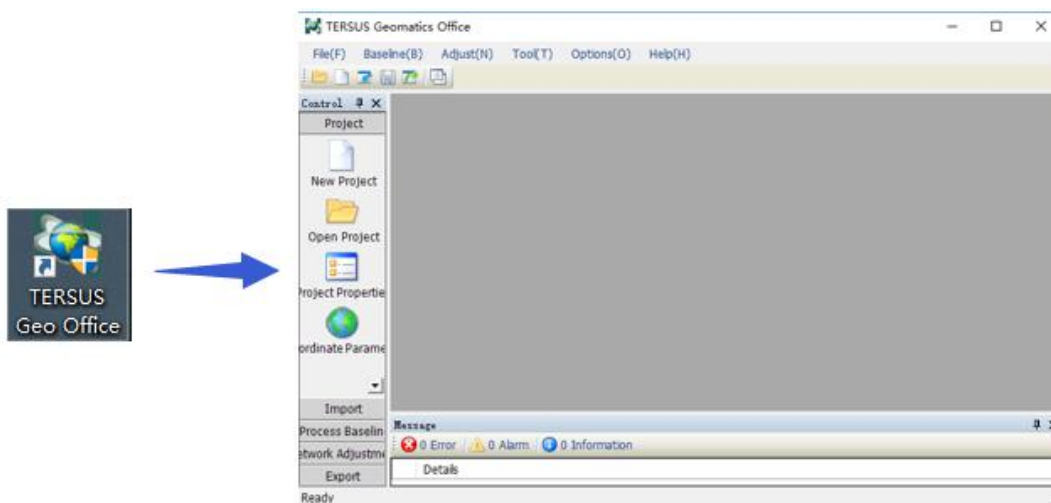


Figure 7.7 TERSUS Geomatics Office interface

After a project is created, click [Import] -> [Import Files]

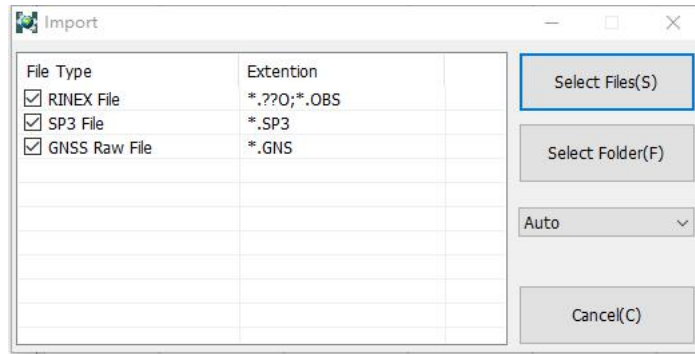


Figure 7.8 Import Files in TERSUS Geo Office

Click [Select Files] to load the Rinex files created in section 6.2.3.

After the above step of importing, the default configuration of the observation data is correct. There is no need to modify the configurations of antenna height, antenna type, and etc. The default configuration of the imported files is shown as follows.

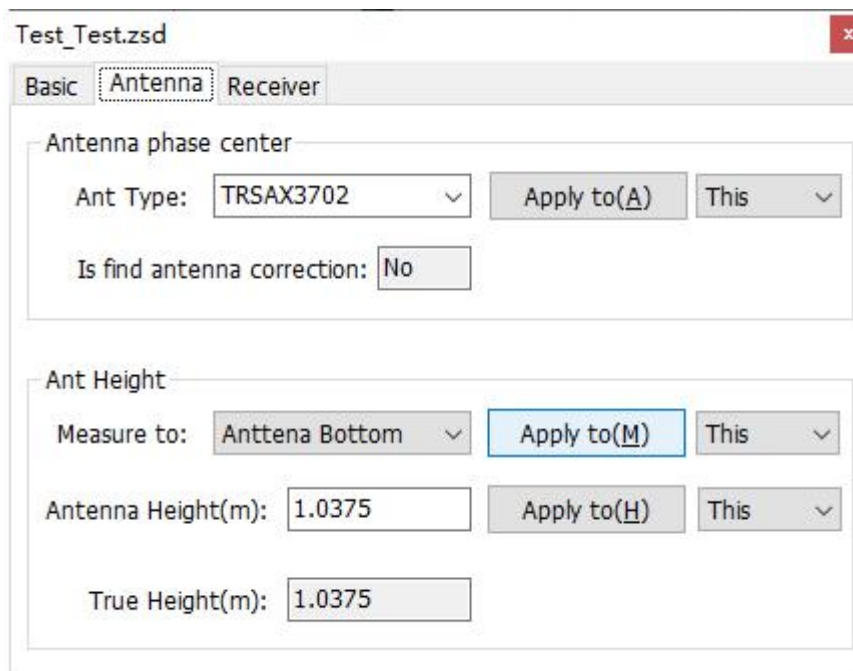


Figure 7.9 Default configuration of the observation data

Refer to the user manual of Tersus Geo Office for more details on data post processing.



## 7.3 Point Correction

1. [Project] -> [New], input a Project Name, select the proper CRS system.



Figure 7.10 Create a new project

2. [Device] -> [Connect], connect to the David receiver.

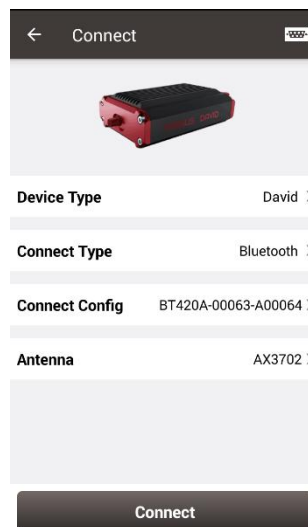


Figure 7.11 Connect to a David receiver

3. [Device] -> [Rover], configure this David as a rover and ensure the rover can get fixed solution.

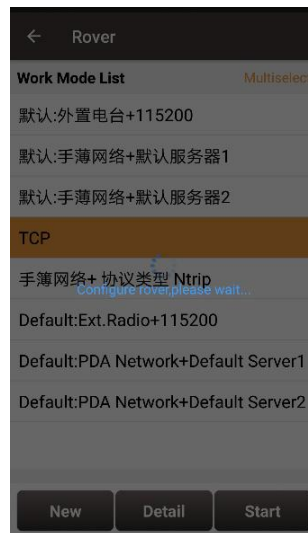


Figure 7.12 Configure David as a rover

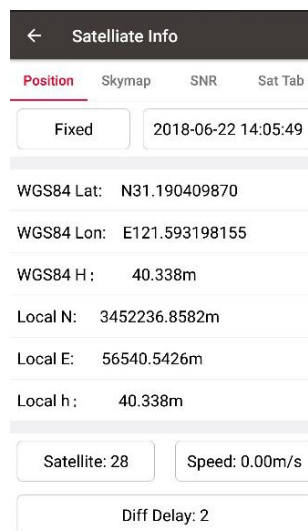
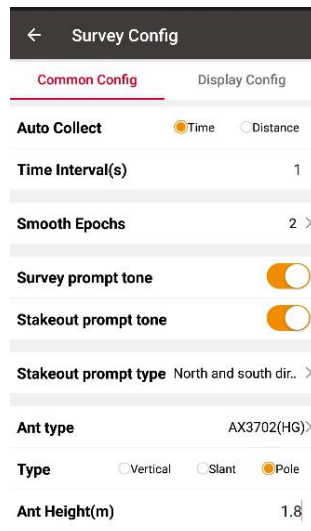


Figure 7.13 Satellite Information

4. [Survey] -> [Survey Config], input the correct antenna height.



Survey Config

Common Config Display Config

Auto Collect  Time  Distance

Time Interval(s) 1

Smooth Epochs 2 >

Survey prompt tone

Stakeout prompt tone

Stakeout prompt type North and south dir. >

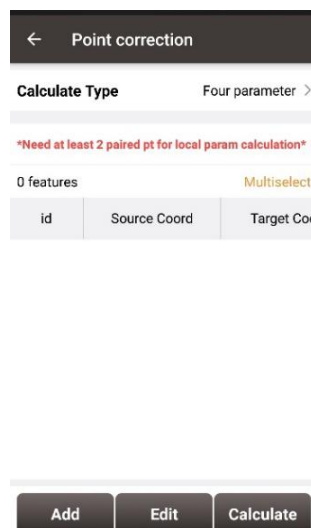
Ant type AX3702(HG) >

Type  Vertical  Slant  Pole

Ant Height(m) 1.8

Figure 7.14 Survey Configuration

- [Survey] -> [Point correction], select the proper method to calculate. The following example is using four parameter method.



Point correction

Calculate Type Four parameter >

*\*Need at least 2 paired pt for local param calculation\**

0 features Multiselect

id	Source Coord	Target Coord
----	--------------	--------------

Add Edit Calculate

Figure 7.15 Point Correction interface

- Click [Add], input the point name for the Source Coordinate. Select a point with known WGS84 coordinates, or survey the point directly. Input the known coordinate in the local CRS for the Target Coordinate.

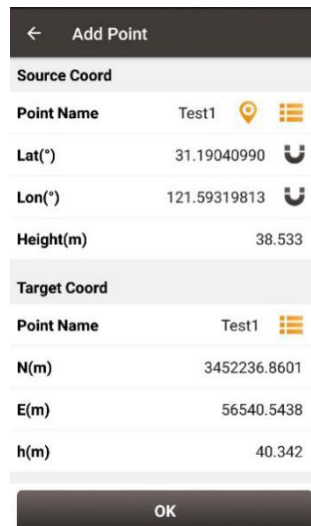
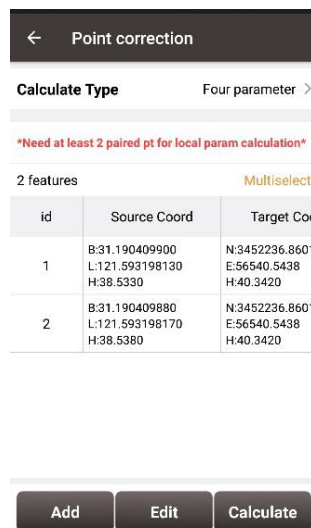


Figure 7.16 Add Point for Point Correction

7. Click [OK].
8. Add the 2nd point with the same procedure as the 1st point.



id	Source Coord	Target Coor
1	B:31.190409900 L:121.593198130 H:38.5330	N:3452236.8601 E:56540.5438 H:40.3420
2	B:31.190409880 L:121.593198170 H:38.5380	N:3452236.8601 E:56540.5438 H:40.3420

Figure 7.17 Two points added for point correction

9. Click [Calculate] and check the calculation result.



Figure 7.18 Calculation result for point correction

10. Click [Apply] to add the parameters to the project.

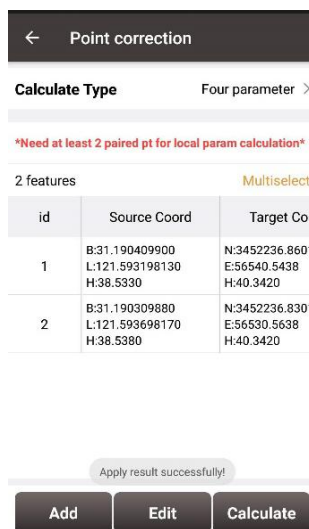


Figure 7.19 Apply result to the project

## 7.4 Issues and Solutions

### 1. Bluetooth / USB cannot be connected.

- (1) Check if other devices have connected to Bluetooth (COMM1-Bluetooth module only supports Android phones);
- (2) Check if the Bluetooth model matches the David GNSS receiver, the David-R model matches the BT420R model of Bluetooth module, and the David model matches the BT420A model of Bluetooth module;
- (3) Check if the David GNSS receiver is powered on normally. If the receiver's LED is bright but cannot search for the Bluetooth name, please delete the matched Bluetooth in the phone and search again. If you still cannot find the Bluetooth device name, please contact the supplier for assistance;
- (4) Reconnect USB and allow USB device to connect when USB cannot be connected;
- (5) If the radio base station mode is used, check the power supply. At this time, only the 12V battery can be used for power supply. Do not use 5V power bank for power supply.

### 2. David GNSS receiver cannot be located.

- (1) Check if the GNSS antenna is properly connected;
- (2) Check if the GNSS antenna cable and connector are intact or damaged.
- (3) Ensure that the GNSS antenna is placed in an open outdoor environment;
- (4) Check if David's LED light is in normal startup state.

### 3. The rover with 2W radio kit cannot obtain a fixed solution.

- (1) Check if the radio 'T/R' LED is in the receiving state with blue light. If it is not in the receiving state, press and hold the 'CHAN' and 'PWR' buttons for about 1 second to switch to the receiving state.
- (2) Check whether the number of channels and the transmission protocol of the rover are consistent with that of the base radio;
- (3) Check whether the baud rate of the serial port of the 2W radio and the base radio is

normal. The baud rate of the serial port of the 2W radio and the 30W radio is 38400bps, and the baud rate of the serial port of the 1W radio is 115200bps.

#### **4. The rover network mode cannot obtain a fixed solution.**

- (1) Check if the network of the rover is normal, and whether the controller (an android device) can connect to the network normally;
- (2) Check if the rover's user name and password are correct, pay attention to case sensitivity, and there is no '@' character at the beginning of the rover's password;
- (3) Check if the rover's MountPoint is consistent with that of the base. It is recommended to use the default base serial number as MountPoint;
- (4) Check if the base has sent corrections data normally.

#### **5. The base radio constantly restarts.**

- (1) In the base radio mode, only 12V battery can be used for power supply, and 5V power bank cannot be used for power supply;
- (2) Check if the battery is low power or insufficient voltage.

#### **6. The local coordinate deviation of the rover is large.**

- (1) Check if the coordinate system of the project in Nuwa application is configured correctly;
- (2) If point correction or parameter calculation is not performed, the base needs to be configured by manual start, and the known point coordinates of the base configuration should be consistent with the known point of the actual installation;
- (3) If point correction or parameter calculation is performed, check whether the coordinate of the control point is incorrectly entered, whether the coordinate deviation of the control point and the distribution of the control point is uniform, and whether the scale is close to 1 in the parameter calculation result.

#### **7. It prompts that the coordinate deviation is large when configuring base.**

- (1) If the input is WGS84 coordinates, check whether the input coordinates are the same

point, and the coordinate difference cannot be greater than 30m;

(2) If the input is local coordinates, check whether the configured coordinate system is consistent with the coordinates that need to be input.

### **8. The time for the rover to get a fixed solution is too long.**

(1) Check the number of satellites for the rover, the satellite distribution (whether the occlusion is serious), and the satellite signal-to-noise ratio (whether the maximum signal-to-noise ratio is greater than 50);

(2) Check if the antenna connection is loose;

(3) Check whether the correction data of the base is normal, and whether it includes correction data of GPS, GLONASS, and BeiDou systems.



## 8. Terminology

<b>Abbreviation</b>	<b>Definition</b>
CRS	Coordinate System
GNSS	Global Navigation Satellite System
HDOP	Horizontal Dilution of Precision
HRMS	Horizontal Root Mean Square
OS	Operating System
PDOP	Position Dilution of Precision
RINEX	Receiver Independent Exchange format
RMS	Root Mean Squares
RTCM	Radio Technical Commission for Maritime Services
RTK	Real-Time Kinematic
SNR	Signal Noise Ratio
UI	User Interface
UTC	Coordinated Universal Time
UTM Projection	Universal Transverse Mercator Projection
VDOP	Vertical Dilution of Precision
VRMS	Vertical Root Mean Square

## 9. File Format

[.apk]: android app installation file

[.csd]: coordinate system file

[.csv]: excel file

[.dat]: data file

[.dxf]: CAD data file developed by Autodesk

[.ggf]: Geoid file

[.kml]: landmark file developed by Google

[.lnb]: line file

[.shp]: shape file developed by ESRI

[.txt]: text file

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